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**Delmar's Test Preparation Series**

# Automobile Test

## Automotive Suspension and Steering (Test A4)

2nd Edition



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Automobile Test**

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2nd Edition**

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# Preface

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This book is just one of a comprehensive series designed to prepare technicians to take and pass every ASE test. Delmar's series covers all of the Automotive tests A1 through A8 as well as Advanced Engine Performance L1 and Parts Specialist P2. The series also covers the five Collision Repair tests and the eight Medium/Heavy Duty truck tests.

Before any book in this series was written, Delmar staff met with and surveyed technicians and shop owners who have taken ASE tests and have used other preparatory materials. We found that they wanted, first and foremost, *lots* of practice tests and questions. Each book in our series contains a sample test and additional practice questions. You will be hard-pressed to find a test prep book with more questions for you to practice with. We have worked hard to ensure that these questions match the ASE style in types of questions, quantities, and level of difficulty.

Technicians also told us that they wanted to understand the ASE test and to have practical information about what they should expect. We have provided that as well, including a history of ASE and a section devoted to helping the technician "Take and Pass Every ASE Test" with case studies, test-taking strategies, and test formats.

Finally, techs wanted refresher information and references. Each of our books includes an overview section that is referenced to the task list. The complete task lists for each test appear in each book for the user's reference. There is also a complete glossary of terms for each booklet.

So whether you're looking for a sample test and a few extra questions to practice with or a complete introduction to ASE testing, with support for preparing thoroughly, this book series is an excellent answer.

We hope you benefit from this book and that you pass every ASE test you take!

Your comments, both positive and negative, are certainly encouraged! Please contact us at:

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# 1

## The History of ASE

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### History

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Originally known as The National Institute for Automotive Service Excellence (NIASE), today's ASE was founded in 1972 as a non-profit, independent entity dedicated to improving the quality of automotive service and repair through the voluntary testing and certification of automotive technicians. Until that time, consumers had no way of distinguishing between competent and incompetent automotive mechanics. In the mid-1960s and early 1970s, efforts were made by several automotive industry affiliated associations to respond to this need. Though the associations were non-profit, many regarded certification test fees merely as a means of raising additional operating capital. Also, some associations, having a vested interest, produced test scores heavily weighted in the favor of its members.

From these efforts a new independent, non-profit association, the National Institute for Automotive Service Excellence (NIASE), was established. In early NIASE tests, Mechanic A, Mechanic B type questions were used. Over the years the trend has not changed, but in mid-1984 the term was changed to Technician A, Technician B to better emphasize sophistication of the skills needed to perform successfully in the modern motor vehicle industry. In certain tests the term used is Estimator A/B, Painter A/B, or Parts Specialist A/B. At about that same time, the logo was changed from "The Gear" to "The Blue Seal," and the organization adopted the acronym ASE for Automotive Service Excellence.

### ASE

ASE's mission is to improve the quality of vehicle repair and service in the United States through the testing and certification of automotive repair technicians. Prospective candidates register for and take one or more of ASE's many exams.

Upon passing at least one exam and providing proof of two years of related work experience, the technician becomes ASE certified. A technician who passes a series of exams earns ASE Master Technician status. An automobile technician, for example, must pass eight exams for this recognition.

The exams, conducted twice a year at over seven hundred locations around the country, are administered by American College Testing (ACT). They stress real-world diagnostic and repair problems. Though a good knowledge of theory is helpful to the technician in answering many of the questions, there are no questions specifically on theory. Certification is valid for five years. To retain certification, the technician must be retested to renew his or her certificate.

The automotive consumer benefits because ASE certification is a valuable yardstick by which to measure the knowledge and skills of individual technicians, as well as their commitment to their chosen profession. It is also a tribute to the repair facility employing ASE certified technicians. ASE certified technicians are permitted to wear blue and white ASE shoulder insignia, referred to as the "Blue Seal of Excellence," and carry credentials

listing their areas of expertise. Often employers display their technicians' credentials in the customer waiting area. Customers look for facilities that display ASE's Blue Seal of Excellence logo on outdoor signs, in the customer waiting area, in the telephone book (Yellow Pages), and in newspaper advertisements.

To become ASE certified, contact:

National Institute for Automotive Service Excellence  
13505 Dulles Technology Drive  
Herndon, VA 20171-3421





B says a tram gauge can be used when a tape measure cannot measure in a straight line from point to point. Who is right?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Analysis:

With some vehicles built asymmetrically, side-to-side measurements are not always equal. The manufacturer's specifications need to be verified with a dimension chart before reaching any conclusions about the structural damage.

Answer A is wrong. Technician A's statement is wrong. A tram gauge would provide a point-to-point measurement when a part, such as a strut tower or air cleaner, interrupts a direct line between the points.

**Answer B is correct.** Technician B is correct. A tram gauge can be used when a tape measure cannot be used to measure in a straight line from point to point.

Answer C is wrong. Since Technician A is not correct, C cannot be the correct answer.

Answer D is wrong. Since Technician B is correct, D cannot be the correct answer.

## Most-Likely Questions

Most-likely questions are somewhat difficult because only one choice is correct while the other three choices are nearly correct. An example of a most-likely-cause question is as follows:

The most likely cause of reduced turbocharger boost pressure may be a:

- A. westgate valve stuck closed.
- B. westgate valve stuck open.
- C. leaking westgate diaphragm.
- D. disconnected westgate linkage.

Analysis:

Answer A is wrong. A westgate valve stuck closed increases turbocharger boost pressure.

**Answer B is correct.** A westgate valve stuck open decreases turbocharger boost pressure.

Answer C is wrong. A leaking westgate valve diaphragm increases turbocharger boost pressure.

Answer D is wrong. A disconnected westgate valve linkage will increase turbocharger boost pressure.

## LEAST-Likely Questions

Notice that in most-likely questions there is no capitalization. This is not so with LEAST-likely type questions. For this type of question, look for the choice that would be the least likely cause of the described situation. Read the entire question carefully before choosing your answer. An example is as follows:

What is the LEAST likely cause of a bent pushrod?

- A. Excessive engine speed
- B. A sticking valve
- C. Excessive valve guide clearance
- D. A worn rocker arm stud

Before beginning to take an objective test, quickly look over the test to determine the number of questions, but do not try to read through all of the questions. In an ASE test, there are usually between forty and eighty questions, depending on the subject. Read through each question before marking your answer. Answer the questions in the order they appear on the test. Leave the questions blank that you are not sure of and move on to the next question. You can return to those unanswered questions after you have finished the others. They may be easier to answer at a later time after your mind has had additional time to consider them on a subconscious level. In addition, you might find information in other questions that will help you to answer some of them.

Do not be obsessed by the apparent pattern of responses. For example, do not be influenced by a pattern like **d, c, b, a, d, c, b, a** on an ASE test.

There is also a lot of folk wisdom about taking objective tests. For example, there are those who would advise you to avoid response options that use certain words such as *all, none, always, never, must, and only*, to name a few. This, they claim, is because nothing in life is exclusive. They would advise you to choose response options that use words that allow for some exception, such as *sometimes, frequently, rarely, often, usually, seldom, and normally*. They would also advise you to avoid the first and last option (A and D) because test writers, they feel, are more comfortable if they put the correct answer in the middle (B and C) of the choices. Another recommendation often offered is to select the option that is either shorter or longer than the other three choices because it is more likely to be correct. Some would advise you to never change an answer since your first intuition is usually correct.

Although there may be a grain of truth in this folk wisdom, ASE test writers try to avoid them and so should you. There are just as many **A** answers as there are **B** answers, just as many **D** answers as **C** answers. As a matter of fact, ASE tries to balance the answers at about 25 percent per choice **A, B, C, and D**. There is no intention to use “tricky” words, such as outlined above. Put no credence in the opposing words “sometimes” and “never,” for example.

Multiple-choice tests are sometimes challenging because there are often several choices that may seem possible, and it may be difficult to decide on the correct choice. The best strategy, in this case, is to first determine the correct answer before looking at the options. If you see the answer you decided on, you should still examine the options to make sure that none seem more correct than yours. If you do not know or are not sure of the answer, read each option very carefully and try to eliminate those options that you know to be wrong. That way, you can often arrive at the correct choice through a process of elimination.

If you have gone through all of the test and you still do not know the answer to some of the questions, then guess. Yes, guess. You then have at least a 25 percent chance of being correct. If you leave the question blank, you have no chance. In ASE tests, there is no penalty for being wrong.

## Preparing for the Exam

The main reason we have included so many sample and practice questions in this guide is, simply, to help you learn what you know and what you don't know. We recommend that you work your way through each question in this book. Before doing this, carefully look through Section 3; it contains a description and explanation of the questions you'll find in an ASE exam.

Once you know what the questions will look like, move to the sample test. After you have answered one of the sample questions (Section 5), read the explanation (Section 7) to the answer for that question. If you don't feel you understand the reasoning for the correct answer, go back and read the overview (Section 4) for the task that is related to

that question. If you still don't feel you have a solid understanding of the material, identify a good source of information on the topic, such as a textbook, and do some more studying.

After you have completed the sample test, move to the additional questions (Section 6). This time answer the questions as if you were taking an actual test. Once you have answered all of the questions, grade your results using the answer key in Section 7. For every question that you gave a wrong answer to, study the explanations to the answers and/or the overview of the related task areas.

Here are some basic guidelines to follow while preparing for the exam:

- Focus your studies on those areas you are weak in.
- Be honest with yourself while determining if you understand something.
- Study often but in short periods of time.
- Remove yourself from all distractions while studying.
- Keep in mind the goal of studying is not just to pass the exam, the real goal is to learn!

## During the Test

Mark your bubble sheet clearly and accurately. One of the biggest problems an adult faces in test-taking, it seems, is in placing an answer in the correct spot on a bubble sheet. Make certain that you mark your answer for, say, question 21, in the space on the bubble sheet designated for the answer for question 21. A correct response in the wrong bubble will probably be wrong. Remember, the answer sheet is machine scored and can only "read" what you have bubbled in. Also, do not bubble in two answers for the same question.

If you finish answering all of the questions on a test ahead of time, go back and review the answers of those questions that you were not sure of. You can often catch careless errors by using the remaining time to review your answers.

At practically every test, some technicians will invariably finish ahead of time and turn their papers in long before the final call. Do not let them distract or intimidate you. Either they knew too little and could not finish the test, or they were very self-confident and thought they knew it all. Perhaps they were trying to impress the proctor or other technicians about how much they know. Often you may hear them later talking about the information they knew all the while but forgot to respond on their answer sheet.

It is not wise to use less than the total amount of time that you are allotted for a test. If there are any doubts, take the time for review. Any product can usually be made better with some additional effort. A test is no exception. It is not necessary to turn in your test paper until you are told to do so.

## Your Test Results!

You can gain a better perspective about tests if you know and understand how they are scored. ASE's tests are scored by American College Testing (ACT), a non-partial, non-biased organization having no vested interest in ASE or in the automotive industry. Each question carries the same weight as any other question. For example, if there are fifty questions, each is worth 2 percent of the total score. The passing grade is 70 percent. That means you must correctly answer thirty-five of the fifty questions to pass the test.

The test results can tell you:

- where your knowledge equals or exceeds that needed for competent performance, or
- where you might need more preparation.

The test results *cannot* tell you:

- how you compare with other technicians, or
- how many questions you answered correctly.

Your ASE test score report will show the number of correct answers you got in each of the content areas. These numbers provide information about your performance in each area of the test. However, because there may be a different number of questions in each area of the test, a high percentage of correct answers in an area with few questions may not offset a low percentage in an area with many questions.

It may be noted that one does not “fail” an ASE test. The technician who does not pass is simply told “More Preparation Needed.” Though large differences in percentages may indicate problem areas, it is important to consider how many questions were asked in each area. Since each test evaluates all phases of the work involved in a service specialty, you should be prepared in each area. A low score in one area could keep you from passing an entire test.

There is no such thing as average. You cannot determine your overall test score by adding the percentages given for each task area and dividing by the number of areas. It doesn't work that way because there generally are not the same number of questions in each task area. A task area with twenty questions, for example, counts more toward your total score than a task area with ten questions.

Your test report should give you a good picture of your results and a better understanding of your task areas of strength and weakness.

If you fail to pass the test, you may take it again at any time it is scheduled to be administered. You are the only one who will receive your test score. Test scores will not be given over the telephone by ASE nor will they be released to anyone without your written permission.

# 3

## Types of Questions on an ASE Exam

ASE certification tests are often thought of as being tricky. They may seem to be tricky if you do not completely understand what is being asked. The following examples will help you recognize certain types of ASE questions and avoid common errors.

Each test is made up of forty to eighty multiple-choice questions. Multiple-choice questions are an efficient way to test knowledge. To answer them correctly, you must think about each choice as a possibility, and then choose the one that best answers the question. To do this, read each word of the question carefully. Do not assume you know what the question is about until you have finished reading it.

About 10 percent of the questions on an actual ASE exam will use an illustration. These drawings contain the information needed to correctly answer the question. The illustration must be studied carefully before attempting to answer the question. Often, techs look at the possible answers then try to match up the answers with the drawing. Always do the opposite; match the drawing to the answers. When the illustration is showing an electrical schematic or another system in detail, look over the system and try to figure out how the system works before you look at the question and the possible answers.

### Multiple-Choice Questions

One type of multiple-choice question has three wrong answers and one correct answer. The wrong answers, however, may be almost correct, so be careful not to jump at the first answer that seems to be correct. If all the answers seem to be correct, choose the answer that is the most correct. If you readily know the answer, this kind of question does not present a problem. If you are unsure of the answer, analyze the question and the answers. For example:

A rocker panel is a structural member of which vehicle construction type?

- A. Front-wheel drive
- B. Pickup truck
- C. Unibody
- D. Full-frame

Analysis:

This question asks for a specific answer. By carefully reading the question, you will find that it asks for a construction type that uses the rocker panel as a structural part of the vehicle.

Answer A is wrong. Front-wheel drive is not a vehicle construction type.

Answer B is wrong. A pickup truck is not a type of vehicle construction.

**Answer C is correct.** Unibody design creates structural integrity by welding parts together, such as the rocker panels, but does not require exterior cosmetic panels installed for full strength.

Answer D is wrong. Full-frame describes a body-over-frame construction type that relies on the frame assembly for structural integrity.

Therefore, the correct answer is C. If the question was read quickly and the words "construction type" were passed over, answer A may have been selected.

## EXCEPT Questions

Another type of question used on ASE tests has answers that are all correct except one. The correct answer for this type of question is the answer that is wrong. The word "EXCEPT" will always be in capital letters. You must identify which of the choices is the wrong answer. If you read quickly through the question, you may overlook what the question is asking and answer the question with the first correct statement. This will make your answer wrong. An example of this type of question and the analysis is as follows:

All of the following are tools for the analysis of structural damage EXCEPT:

- A. height gauge.
- B. tape measure.
- C. dial indicator.
- D. tram gauge.

Analysis:

The question really requires you to identify the tool that is not used for analyzing structural damage. All tools given in the choices are used for analyzing structural damage except one. This question presents two basic problems for the test-taker who reads through the question too quickly. It may be possible to read over the word "EXCEPT" in the question or not think about which type of damage analysis would use answer C. In either case, the correct answer may not be selected. To correctly answer this question, you should know what tools are used for the analysis of structural damage. If you cannot immediately recognize the incorrect tool, you should be able to identify it by analyzing the other choices.

Answer A is wrong. A height gauge *may* be used to analyze structural damage.

Answer B is wrong. A tape measure may be used to analyze structural damage.

**Answer C is correct.** A dial indicator may be used as a damage analysis tool for moving parts, such as wheels, wheel hubs, and axle shafts, but would not be used to measure structural damage.

Answer D is wrong. A tram gauge *is* used to measure structural damage.

## Technician A, Technician B Questions

The type of question that is most popularly associated with an ASE test is the "Technician A says. . . Technician B says. . . Who is right?" type. In this type of question, you must identify the correct statement or statements. To answer this type of question correctly, you must carefully read each technician's statement and judge it on its own merit to determine if the statement is true.

Typically, this type of question begins with a statement about some analysis or repair procedure. This is followed by two statements about the cause of the problem, proper inspection, identification, or repair choices. You are asked whether the first statement, the second statement, both statements, or neither statement is correct. Analyzing this type of question is a little easier than the other types because there are only two ideas to consider although there are still four choices for an answer.

Technician A, Technician B questions are really double true or false questions. The best way to analyze this kind of question is to consider each technician's statement separately. Ask yourself, is A true or false? Is B true or false? Then select your answer from the four choices. An important point to remember is that an ASE Technician A, Technician B question will never have Technician A and B directly disagreeing with each other. That is why you must evaluate each statement independently. An example of this type of question and the analysis of it follows.

Structural dimensions are being measured. Technician A says comparing measurements from one side to the other is enough to determine the damage. Technician

B says a tram gauge can be used when a tape measure cannot measure in a straight line from point to point. Who is right?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Analysis:

With some vehicles built asymmetrically, side-to-side measurements are not always equal. The manufacturer's specifications need to be verified with a dimension chart before reaching any conclusions about the structural damage.

Answer A is wrong. Technician A's statement is wrong. A tram gauge would provide a point-to-point measurement when a part, such as a strut tower or air cleaner, interrupts a direct line between the points.

**Answer B is correct.** Technician B is correct. A tram gauge can be used when a tape measure cannot be used to measure in a straight line from point to point.

Answer C is wrong. Since Technician A is not correct, C cannot be the correct answer.

Answer D is wrong. Since Technician B is correct, D cannot be the correct answer.

## Most-Likely Questions

Most-likely questions are somewhat difficult because only one choice is correct while the other three choices are nearly correct. An example of a most-likely-cause question is as follows:

The most likely cause of reduced turbocharger boost pressure may be a:

- A. westgate valve stuck closed.
- B. westgate valve stuck open.
- C. leaking westgate diaphragm.
- D. disconnected westgate linkage.

Analysis:

Answer A is wrong. A westgate valve stuck closed increases turbocharger boost pressure.

**Answer B is correct.** A westgate valve stuck open decreases turbocharger boost pressure.

Answer C is wrong. A leaking westgate valve diaphragm increases turbocharger boost pressure.

Answer D is wrong. A disconnected westgate valve linkage will increase turbocharger boost pressure.

## LEAST-Likely Questions

Notice that in most-likely questions there is no capitalization. This is not so with LEAST-likely type questions. For this type of question, look for the choice that would be the least likely cause of the described situation. Read the entire question carefully before choosing your answer. An example is as follows:

What is the LEAST likely cause of a bent pushrod?

- A. Excessive engine speed
- B. A sticking valve
- C. Excessive valve guide clearance
- D. A worn rocker arm stud

Analysis:

Answer A is wrong. Excessive engine speed may cause a bent pushrod.

Answer B is wrong. A sticking valve may cause a bent pushrod.

**Answer C is correct.** Excessive valve clearance will not generally cause a bent pushrod.

Answer D is wrong. A worn rocker arm stud may cause a bent pushrod.

## Summary

There are no four-part multiple-choice ASE questions having “none of the above” or “all of the above” choices. ASE does not use other types of questions, such as fill-in-the-blank, completion, true-false, word-matching, or essay. ASE does not require you to draw diagrams or sketches. If a formula or chart is required to answer a question, it is provided for you. There are no ASE questions that require you to use a pocket calculator.

## Testing Time Length

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An ASE test session is four hours and fifteen minutes. You may attempt from one to a maximum of four tests in one session. It is recommended, however, that no more than a total of 225 questions be attempted at any test session. This will allow for just over one minute for each question.

Visitors are not permitted at any time. If you wish to leave the test room, for any reason, you must first ask permission. If you finish your test early and wish to leave, you are permitted to do so only during specified dismissal periods.

You should monitor your progress and set an arbitrary limit to how much time you will need for each question. This should be based on the number of questions you are attempting. It is suggested that you wear a watch because some facilities may not have a clock visible to all areas of the room.



# 4

## An Overview of the System

### Suspension and Steering (Test A4)

The following section includes the task areas and task lists for this test and a written overview of the topics covered in the test.

The task list describes the actual work you should be able to do as a technician that you will be tested on by the ASE. This is your key to the test and you should review this section carefully. We have based our sample test and additional questions upon these tasks, and the overview section will also support your understanding of the task list. ASE advises that the questions on the test may not equal the number of tasks listed; the task lists tell you what ASE expects you to know how to do and be ready to be tested upon.

At the end of each question in the Sample Test and Additional Test Questions sections, a letter and number will be used as a reference back to this section for additional study. Note the following example: **A.3.1**.

#### Task List

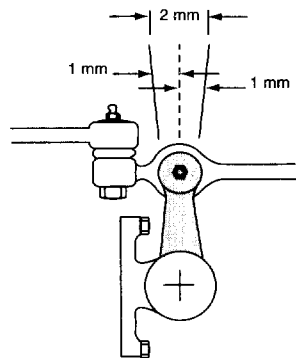
##### A. Steering Systems Diagnosis and Repair (10 Questions)

##### 3. Steering Linkage (3 Questions)

#### Task A.3.1

Inspect and adjust (where applicable) front and rear steering linkage geometry including parallelism and vehicle ride height.

Example:



30. If the measurement shown is more than specified, the problem that may result is a:
- A. front wheel shimmy.
  - B. steering pull to the left.
  - C. steering pull to the right.
  - D. excessive steering effort.

(A.3.1)

Analysis:

Question #30

**Answer A is correct.**

Answer B is wrong. If the above situation exists, it would not pull to one direction or the other.

Answer C is wrong. If the above situation exists, it would not pull to one direction or the other.

Answer D is wrong. Excessive play in the steering linkage causes the steering effort to decrease.

## Task List and Overview

### A. Steering Systems Diagnosis and Repair (10 Questions)

#### 1. Steering Columns and Manual Steering Gears (3 Questions)

##### Task A.1.1

**Diagnose steering column noises and steering effort concerns (including manual and electronic tilt and telescoping mechanisms); determine needed repairs.**

A worn flexible coupling, a worn steering U-joint, loose steering gear mounting bolts, or preload may cause excessive steering wheel free play.

When the subframe is serviced, it must be centered as it is tightened into position. The steering column must be centered and neutralized whenever work is done in that area. Off-center subframes and off-center steering columns can cause binding in the steering columns. Many front-wheel-drive vehicles have a subframe supporting the engine, transmission, and much of the drive train, with steering components attached. When it is loosened or removed for service, it must be centered as it is tightened into position. There are slotted holes in the brackets attaching the steering column to the chassis braces under the dash. The column must be centered and neutralized whenever work is done in that area.

##### Task A.1.2

**Diagnose manual steering gear (non-rack-and-pinion type) noises, binding vibration, uneven turning effort, looseness, hard steering, and lubricant leakage problems; determine needed repairs.**

A loose worm bearing preload adjustment causes excessive steering wheel free play. An overfilled steering system does not affect steering effort. When the positive caster is less than specified, steering effort is reduced. A tight sector lash adjustment increases steering effort.

A cracked mount plate on the steering gear at the frame will produce loud snapping noises when making a turn. The vehicle may turn in a tighter circle in one direction. A bent steering column will produce a rubbing noise, and the vehicle will be harder to steer with no change in turning radius. Noises, binding, looseness, and hard steering can also be caused by bad bearings, due to a lack of lubrication in the manual steering box, or by loose attaching bolts.

##### Task A.1.3

**Diagnose rack-and-pinion steering gear noises, binding vibration, looseness, hard steering problems, and lubricant leakage concerns; determine needed repairs.**

A loose rack bearing adjustment or loose steering gear mounting bolts can cause excessive steering wheel free play. Excessive positive camber causes wear on the outside edge of the tire treads. Insufficient or improper steering gear lubricant may result in poor steering wheel returnability.

Rack-and-pinion steering systems do not have an idler arm. If the rack body has been damaged, binding may occur while the mechanism moves past the bad spot while turning the steering wheel. Bad teeth on the rack or pinion or a rough spot on the rack shaft can also cause binding in one or more spots.

**Task A.1.4**      **Inspect and replace steering column, steering shaft U-joint(s), flexible coupling(s), collapsible columns, and steering wheels (includes steering wheels with air bags and/or other steering wheel mounted controls and components).**

Inspecting and servicing mechanical components of the steering column are straightforward operations. If the vehicle has air bags, you must disable the air bag system before servicing the steering column.

Obtain the vehicle manufacturer's instructions for disabling the air bags and follow them precisely. In the absence of the carmaker's instructions, you can usually disable air bags by removing the system fuse or disconnecting the battery ground cable. Importantly, wait two to five minutes after disconnecting electrical power before working around air bag system components. The capacitors that activate air bag igniters require several minutes to discharge.

**Task A.1.5**      **Remove and replace manual steering gear (non-rack-and-pinion type) (includes vehicles equipped with air bags and/or other steering wheel mounted controls and components).**

Removing and replacing manual steering gear components are straightforward operations. If the vehicle has air bags, you must disable the air bag system before servicing any steering components that contain, or are near, air bag system components. Observe the guidelines summarized for task 4, above.

Wheel alignment should be checked, and adjusted if necessary, if any components are loosened or removed that affect caster, camber, or toe adjustments.

**Task A.1.6**      **Adjust manual steering gear (non-rack-and-pinion type) worm bearing preload and sector lash.**

After a turning torque reading is taken with the steering gear centered and the sector lash adjusting screw is backed off, the sector lash adjusting screw should be turned clockwise until the turning torque is 4 to 10 in. lbs. (0.52 to 1.3 Nm) more than it was with the screw backed off.

Most specifications for worm shaft bearing preload are in inch-pounds of rotating torque. Sector shaft lash adjustment is made after worm shaft bearing adjustment. Worm shaft bearing preload is given in inch-pounds and sector lash is adjusted with the worm and sector centered.

**Task A.1.7**      **Remove and replace rack-and-pinion steering gear (includes vehicles equipped with air bags and/or other steering wheel mounted controls and components).**

The lower universal joint and steering gear pinion shaft must be marked so they may be reassembled in the same position. Before disconnecting any related components from the rack and pinion, mark the lower universal joint and steering gear pinion for reassembly.

Disconnecting the battery erases most fault codes stored in electronic control modules. The codes, if any, should be recorded before the battery is disconnected. Many electronic modules store fault codes in memory for as many as 80 ignition cycles.

Both power and manual rack-and-pinion assemblies have basically the same adjustments. On a manual rack and pinion, the pinion bearings must be preloaded to

specifications, and then the turning torque of the pinion must be set with the rack centered. Rack-and-pinion assemblies are very sensitive to proper settings since they have fewer parts and are a more direct connection to the wheels than steering-box type systems.

**Task**            **Adjust manual rack-and-pinion steering gear.**

**A.1.8**

Worn lower ball joints have little effect on steering effort. A tight rack bearing adjustment can cause excessive steering effort.

**Task**            **Inspect and replace manual rack-and-pinion steering gear inner tie rod ends (sockets) and bellow boots.**

**A.1.9**

The inner tie rod end should be replaced if the articulation effort is less than specified. The rack must be held while loosening the inner tie rod ends.

**Task**            **Inspect and replace rack-and-pinion steering gear mounting bushings and brackets.**

**A.1.10**

The mounting points for rack-and-pinion assemblies have large rubber or urethane bushings. Inspect these bushings for damage and wear typical of that which may happen to similar rubber parts. Replacement is a straightforward mechanical procedure.

Loose or damaged mounting bushings can let the rack-and-pinion assembly move on the vehicle frame. The result is often vague or erratic steering response. Loose rack mountings also can cause bump steer or irregular steering movement during acceleration and deceleration.

You may have to disconnect the steering shaft on some vehicles when you replace rack-and-pinion bushings. On some vehicles, it is also good practice to check and adjust the front wheel toe angle after bushing replacement.

## **2. Power-Assisted Steering Units (4 Questions)**

**Task**            **Diagnose power steering gear (non-rack-and-pinion type) noises, binding vibration, steering effort, freeplay, steering pull (lead), and fluid leakage problems; determine needed repairs.**

**A.2.1**

A loose or worn power steering belt, or low power steering fluid level, may cause increased or erratic steering effort. A scored steering gear cylinder can also result in increased steering effort. A loose worm shaft bearing preload can cause excessive looseness in a power steering gear (non-rack-and-pinion type).

If there is too much movement at the lower end of the sector shaft, because the bearing or bushing is worn, the seal will have a short life. If the vehicle has rough handling, or if the Pitman arm has been removed without using the proper puller, the sector shaft top cover could be damaged. It is possible, on some steering boxes, to install new seals without removing the steering box from the vehicle; however the repair might not last if the bushings or bearings are loose. Complete disassembly and inspection are recommended to verify that the upper and lower supports (bearings or bushings) for the sector shaft are within specifications.

Any tie rod end, Pitman arm, or center link that has a ball-and-socket rotating part must be replaced if it is loose or binding. Any tapered seat involved with a suspension or steering part must be replaced if it is oversized and does not provide a firm and tight grip. Free play is not allowed in any steering part or in any non-load-carrying ball joint. Loose steering parts cause rapid tire wear, vibrations, and shimmy.

**Task  
A.2.2**      **Diagnose power rack-and-pinion steering gear noise, binding vibration, looseness, hard steering, steering pull (lead), and fluid leakage problems; determine needed repairs.**

If the power rack-and-pinion steering gear has an oil leak at the left end of the rack, when the rack contacts the left inner stop, the inner rack seal is leaking. When a leak at this location is not influenced by rack position, the pinion seal is leaking.

If the inner rack seals are leaking, the rack should be rebuilt or replaced because the inner rack seals will allow oil into the boots.

Steering effort imbalance, or loss of power assist in both directions, may be caused by the following: faulty rack seals, faulty rotary valve rings and seals, or restricted hoses and lines.

A slight leak is considered weeping. It could be caused by a porous casting and the housing will have to be replaced. Porous castings may be repaired with epoxy if pressurized passages are not involved.

**Task  
A.2.3**      **Inspect power steering fluid level and condition; adjust level in accordance with vehicle manufacturer's recommendations.**

Many vehicle manufacturers recommend checking the power steering fluid level with fluid temperature at 175° F (79° C), so that the maximum expansion rate of the fluid has been reached.

Low fluid levels are the most likely cause of air in the power steering fluids.

**Task  
A.2.4**      **Inspect, adjust, align, and replace power steering pump belt(s) and tensioners.**

When checking power steering belt tension, for every foot (30 cm) of free span, the belt should have ½ inch (12.7 mm) deflection.

The best method of checking the tension of the power steering belt is to use a belt tension gauge. Before adjusting the power steering belt deflection, inspect the condition of the belt and replace the belt as necessary.

**Task  
A.2.5**      **Diagnose power steering pump noises, vibration, and fluid leakage; determine needed repairs.**

The power steering pump is used to develop hydraulic flow, which provides the force needed to operate the steering gear. The pump is typically belt-driven by the engine's crankshaft, providing flow any time the engine is running. The pump assembly includes a reservoir and an internal flow control valve. The fluid is routed to and from the pump by hoses and lines. Excessive pressure is controlled by a relief valve.

The use of a steering system analyzer can provide an accurate way to evaluate the pump, valves, and seals of the power steering unit. The analyzer provides a direct read-out of base pump pressure and flow, pump relief pressure, and steering gear seal integrity. Of course each of these can also be checked with a set of control valves and good pressure gauges. The pump's pressure should always be checked according to the manufacturer's recommendations.

**Task  
A.2.6**      **Remove and replace power steering pump; inspect pump mounting and bolts.**

The power steering pump fluid must be drained before attempting to remove the power steering pump and/or related components. Disconnect the power steering return hose from the remote reservoir or pump and allow the fluid to drain.

Most pumps have bolt holes that allow bracket attachment or direct mounting to the block or cylinder head. If these bolt holes are worn or damaged, it is best to replace the pump.

Replacing the front seal is a common repair on power steering pumps and can often be done without removing the pump from the vehicle. The reservoir and its sealing O-ring can be purchased and replaced and the original pump body reused. The main reasons for removing, repairing, and/or replacing a power steering pump are leaks and noise.

### **Task A.2.7**

#### **Inspect and replace power steering pump seals, gaskets, reservoir and valves.**

When a power steering pump with an integral reservoir is leaking fluid between the reservoir and the pump housing, the large housing O-ring is faulty.

When installing new seals to the power steering pump or power steering hoses, the seals should only be coated with power steering fluid, so as not to introduce any contaminants into the system.

Power steering pumps often have about  $\frac{1}{16}$  inch (1.6 mm) of shaft end play, which actually helps with belt alignment. This end play is not adjustable. Occasionally the wrong fluid is put in the power steering system, but that is not one of the main reasons for seal and gasket failure. Old age, overheating, or prying in the wrong place during belt adjustment are common reasons for seal, O-ring, and gasket leaks on a power steering pump.

### **Task A.2.8**

#### **Inspect and replace power steering pump pulley.**

Power steering pump pulley alignment is a problem on some vehicles, causing belt noise, short belt life, and belts to jump off the pulleys. Pump pulley tools are available that allow alignment of the pulleys without removal of the pump on many vehicles. Shimming of the brackets would only move the pulley in one direction and could cause vibrations or bracket breakage.

It is not necessary to disassemble the power steering pump to replace the pulley. Replacement pulleys are not pushed on as far as the tool can push them onto the shaft. If it is a high mileage unit, or if the power steering fluid is dark and smells burned, new seals, gaskets, and O-rings should be installed when the pulley is replaced. Bent pulleys shorten belt and seal life and cause vibrations.

### **Task A.2.9**

#### **Perform power steering system pressure and flow tests; determine needed repairs.**

During a power steering pump pressure test, the pressure gauge valve should never be closed for more than ten seconds while observing pump output pressure. If the gauge valve is closed for more than ten seconds, excessive pump pressure could cause a power steering hose to rupture, resulting in injury.

When the power steering pump pressure test indicates satisfactory pump pressure, but the steering wheel effort is excessive, the steering gear may be defective, or the high-pressure hose may be restricted.

Four to five gallons (15 to 19 liters) per minute at 2,000 rpm, with the wheels straight ahead, is an acceptable flow rate for most power steering systems. The maximum pressure in most systems is between 950 and 1,250 psi (6,550 and 8,619 kPa), depending on the design of the system. The power steering analyzer is a very useful tool to diagnose restricted hoses, stuck flow control valves, stuck pressure relief valves, and internal problems in power steering boxes or power rack-and-pinion assemblies.

### **Task A.2.10**

#### **Inspect and replace power steering hoses, fittings, O-rings, and coolers.**

If there is a leak at a threaded fitting, the fitting should be properly torqued. If the leak persists, the fitting should be removed for inspection and any O-ring or plastic inserts should be replaced. This should repair the leak. If fluid is leaking at the molded steel fitting connection to the flexible hose, the hose must be replaced. If the hose is

contacting the body and transmitting noise, simply reroute the hose and put insulating material on the hose.

### **Task A.2.11**

#### **Remove and replace power steering gear (non-rack-and-pinion type) (includes vehicles equipped with air bags and/or other steering wheel mounted controls and components).**

Following are the basic steps to remove and replace a power steering gear.

1. Determine if the steering column must be removed or loosened inside the vehicle. If it must be removed or loosened, proceed as follows. If not, proceed with undercar and underhood operations beginning with step 2.
  - a. Disconnect the battery ground cable and remove the air bag fuse, or fuses, if equipped. If the vehicle has air bags, wait two to five minutes before proceeding.
  - b. Disconnect electrical connectors from the steering column under the instrument panel.
  - c. Loosen or remove the steering column mounting bolts from the instrument panel bracket.
2. Disconnect the power steering hoses from the steering gearbox and drain the fluid into a suitable container.
3. If necessary for access, remove the power steering pump and any other engine-driven accessories, as required.
4. Disconnect the steering column from the steering gearbox.
5. Remove the Pitman arm from the gearbox sector shaft, using a suitable puller.
6. Unbolt the steering gearbox from the chassis and remove it from the vehicle.
7. Reinstallation is the reverse of removal.
8. After installing the steering gearbox and reconnecting the hoses, fill the pump with fluid and bleed air from the system.

### **Task A.2.12**

#### **Remove and replace power rack-and-pinion steering gear; inspect and replace mounting bushings and brackets (includes vehicles equipped with air bags and/or other steering wheel mounted controls and components).**

When removing the steering wheel on a vehicle with an air bag, disconnect the negative battery cable and wait the time specified by the car manufacturer before working on the vehicle. This time is usually two to five minutes. Rotating the steering wheel with the steering gear disconnected may damage the clockspring electrical connector.

Old age or excessive heat cause the rack bushings to dry out and deteriorate and not hold the rack in place. There will be noises as the rack shifts from side to side during hard turns. Engine oil, transmission oil, or gasoline will damage the rack bushings. They will become soft and no longer hold the rack in place. Loose or dried out bushings and soft, mushy bushings cause noises in the rack area when making turns. Brackets must fit correctly and bushings must be in good condition to hold the rack in place and minimize road shock.

### **Task A.2.13**

#### **Adjust power steering gear (non-rack-and-pinion type) worm bearing preload and sector lash.**

When adjusting the worm shaft bearing preload on some steering gears, the adjuster plug should be bottomed and tightened to 20 ft. lbs. (27 Nm). After the procedure, the adjuster plug is backed off 0.05 inch (1.27 mm).

Normal torque for many steering box worm bearing adjuster nuts is 20 ft. lbs. (27 Nm), but most require another step to properly set preload. Worm shaft bearings are always preloaded so there will never be any lash (free motion) in the worm bearings. Different manufacturers have slightly different methods of adjusting worm shaft bearings, but the result is always a slight preload. The sector shaft adjustment also differs slightly on different vehicles, but the desired result is always slightly more turning force through the center of travel than was present with only the worm bearing preload.

**Task  
A.2.14**      **Inspect and replace power steering gear (non-rack-and-pinion type) seals and gaskets.**

On some vehicles, steering gear seals and gaskets can be replaced with the steering gearbox installed in the vehicle. Other vehicles require that the gearbox be removed.

Inspect the steering gearbox, in or out of the vehicle, for signs of fluid leakage from gaskets and seals. If fluid is leaking from a sector shaft seal or from the end seals of a rack-and-pinion assembly, inspect the shafts (and inner tie rod ends on a rack-and-pinion assembly) for burrs, nicks, or other sharp spots that could have damaged the original seal and that might damage a replacement. Remove nicks and burrs with a fine file and polish with emery cloth before installing a new seal.

Remove old seals with the appropriate removal tool. Inspect the seal bore for nicks and burrs and remove any as necessary. Install the new seal with a suitable installation tool. When installing a lip seal, ensure that the lip points toward the lubricant side (inside) of the gearbox.

**Task  
A.2.15**      **Adjust power rack-and-pinion steering gear.**

Two adjustments may be possible on a rack-and-pinion assembly:

1. Pinion torque is the force needed to turn the pinion gear along the rack. It is adjusted by turning an adjustment screw or a threaded cover on the rack housing or by adding or removing shims under the rack support cover.
2. Pinion bearing preload is the force that the pinion bearings place on the pinion shaft. Only a few steering assemblies have adjustable pinion bearing preload. When it is adjustable, adjustments are made by adding or removing shims or by turning an adjustment collar at the base of the pinion gear.

Most vehicles will require that the rack-and-pinion assembly be removed for adjustment. On some vehicles, you may be able to disconnect the steering shaft and the tie rods and make the adjustments on the car. The steering shaft and tie rods must be disconnected to remove all steering load from the rack-and-pinion assembly.

**Task  
A.2.16**      **Inspect and replace power rack-and-pinion steering gear inner tie rod ends (sockets) and bellows boots.**

To replace the inner tie rod, first the outer tie rod must be disconnected from the steering knuckle. After removing the outer tie rod from the inner tie rod shaft, remove the inner tie rod bellows. To loosen the inner tie rod from the rack-and-pinion assembly, use the appropriate special tool to hold the rack-and-pinion shaft. Use the appropriate tool to loosen the inner tie rod from the rack.

In an electronically controlled steering system, if the control unit senses an electrical defect in the system, the control unit enters the fail-safe mode. When an electronically controlled 4WS steering system enters the fail-safe mode, the voltage is shut off to the rear steering unit. In this mode, the control unit energizes the damper relay, and the rear steering unit moves slowly to the center position. In fail-safe mode, the control unit illuminates the 4WS light in the instrument panel.

The complaint should always be verified and a thorough inspection should be done on all related parts. The control module should then be accessed for fault codes when diagnosing a hard-steering problem. During the road test, the technician will have to determine whether the steering is harder than normal at low speeds, at all speeds, or only at higher speeds, before getting deeper into the diagnosis. All of the basic reasons for hard steering (lack of lubrication, binding parts, and poor alignment) should be eliminated before fault codes are investigated.

**Task  
A.2.17**      **Flush, fill, and bleed power steering system.**

When bleeding a power steering system, the steering wheel should be held in the fully right or fully left position for two to three seconds. If foaming is still present in the reservoir after the bleeding process, the bleeding procedure should be repeated.



Flushing the power steering system is accomplished by disconnecting the return to the pump. Plug the pump return port and fill the power steering reservoir with the recommended fluid. With the front wheels off of the ground and the return hose in a drain pan, start the engine and slowly turn the steering wheel from stop to stop. Flushing the system with two quarts of power steering fluid should be sufficient to remove all contaminants and foreign material. Cleaning solvent should never be used in power steering systems for cleansing or flushing procedures. Power steering pumps need power steering fluid to distribute load forces and to prevent excessive heat buildup.

**Task  
A.2.18**      **Diagnose, inspect, and repair or replace components of variable-assist steering systems.**

In a variable-assist steering system with a steering wheel rotation sensor, the hydraulic boost increases when the steering wheel rotation exceeds a specified limit. Power steering assist also is increased at low speeds and decreased at higher speeds.

The system is designed to provide better feel and control at higher vehicle speeds. The variable steering systems are usually designed to start firming up the steering at speeds over 25 mph (40 km/h) and to reach the maximum firmness between 60 and 80 mph (97 and 129 km/h), depending on design. On most vehicles, the main input for the variable-assist steering systems is the vehicle speed sensor, but some manufacturers also use a steering wheel rotation sensor so the vehicle will revert to full assist during evasive maneuvers. On most vehicles, the system goes to full assist below 25 mph (40 km/h).

**Task  
A.2.19**      **Diagnose, inspect, repair, or replace components of power steering idle speed compensation systems.**

The operation of the power steering pump puts extra load on the engine, especially when the steering wheel is turned to its limits when the vehicle is at a standstill or moving very slowly. Most late-model vehicles are equipped with a switch or sensor that informs the PCM of the increased load on the engine. At that time the PCM orders engine speed to increase in proportion to the load on the engine. This prevents engine loading or stalling when the power steering pump is working hard.

### **3. Steering Linkage (3 Questions)**

**Task  
A.3.1**      **Inspect and adjust (where applicable) front and rear steering linkage geometry, including parallelism and vehicle ride height.**

Excessive idler arm movement may cause front wheel shimmy, steering looseness, improper tie rod alignment with the lower control arm, and bump steer.

Bump steer occurs when the tie rods are not parallel to the lower control arms. This condition may be caused by a bent Pitman arm or a loose idler arm.

**Task  
A.3.2**      **Inspect and replace Pitman arm.**

The main reason for changing Pitman arms is vehicle crashes. Sector shaft preload adjustment would never be corrected by installing a new Pitman arm. Pitman arms are very well built and the splines do not loosen from road shock. The Pitman arms can be bent or broken in vehicle crashes, but more often sector shafts are bent and broken. If the Pitman arm has a ball and socket at one end, it should be replaced when the ball and socket show any looseness.

**Task  
A.3.3**      **Inspect and replace center link (relay rod/drag link/intermediate rod).**

A bent relay rod may cause improper front-wheel toe. This condition causes feathered wear across the tire treads.

**Task A.3.4 Inspect, adjust (where applicable), and replace idler arm and mountings.**

Worn ball joints, weak front springs, or a weak stabilizer bar would not cause excessive steering effort. However, this problem may be caused by a seized idler arm.

Idler arm adjustments keep the center link parallel with the crossmember, which keeps the toe settings right. Idler arm adjustments do not help with road feel.

**Task A.3.5 Inspect, replace, and adjust tie rods, tie rod sleeves, clamps, and tie rod ends (sockets).**

The tie rod sleeves must be rotated to adjust front-wheel toe and center the steering wheel.

Replacing the inner tie rod ends (a common repair) must be done carefully to prevent damage to the pinion teeth on rack-and-pinion steering. The rack must be held firmly while the socket threads are loosened from the threads of the rack.

If the tie rod sleeve clamp is not positioned correctly before tightening, the clamp will not exert enough force to hold the threads together. The constant motion while the vehicle is in operation will wear the threads involved, and the two pieces will pull apart, resulting in loss of steering control. On some vehicles, if the tie rod sleeve clamp is not positioned with the proper orientation, the sleeve bolt could rub against a crossmember or a suspension part or wear through a power steering hose.

**Task A.3.6 Inspect and replace steering linkage damper.**

A scored power steering gear cylinder increases steering effort, but it does not contribute to road shock on the steering wheel. A worn steering damper may cause road shock on the steering wheel.

Steering linkage dampers are designed to help the steering and suspension systems keep road shock and tire vibrations under control. High-speed vibrations are mostly caused by tire and wheel imbalance. Steering linkage dampers work like a shock absorber and are checked the same way one would check for a bad shock.

**B. Suspension Systems Diagnosis and Repair (13 Questions)****1. Front Suspensions (6 Questions)****Task B.1.1 Diagnose front suspension system noises, body sway/roll, and ride height problems; determine needed repairs.**

Reduced front suspension ride height may be caused by weak or broken springs, or worn lower control arm bushings.

Torsion bar suspensions are adjustable to set the correct ride height.

Sway bar bushings that squeak have become worn from use and should be replaced. Lubricating sway bar bushings will temporarily eliminate bushing noise but does not correct the wear of the bushing. If there is a snapping noise, the holes in the frame may have been distorted.

Rear wheel settings must be done first when doing a four-wheel alignment. The proper sequence of checks and adjustments for a four-wheel alignment are: pre-alignment checks, observing tire wear patterns, setup of alignment equipment, rear camber adjustment, rear toe adjustment (ending with the thrust line at zero), front caster, and front camber (caster and camber together when possible). Then bounce the vehicle, center the steering wheel, and set the front toe.

**Task B.1.2 Inspect and replace upper and lower control arms, bushings, shafts, rebound, and jounce bumpers.**

Place safety stands under the lower control arms near the ball joints on most vehicles when replacing the upper control arms, because the springs must be partially com-

pressed. When replacing the lower control arms, the safety stands must support the vehicle by the frame so the arms can move down while the springs are removed. The safety stands must be placed in different positions under the vehicle when replacing upper control arms than when replacing lower control arms because of spring location.

**Task  
B.1.3****Inspect, adjust, and replace strut rods/radius arm (compression/tension), and bushings.**

A worn right front strut rod bushing may result in the lower control arm moving rearward during braking. This action reduces positive caster on the right front wheel. The steering tends to pull to the side with the least positive caster.

Worn strut rod bushings can cause the vehicle to pull to the direction of the worn bushing every time the brakes are applied. Worn strut rod bushings can cause alignment problems. The adjustments available may not allow the desired specification to be reached if the bushings are worn.

**Task  
B.1.4****Inspect and replace upper and lower ball joints (with or without wear indicators).**

When a coil spring is mounted between the lower control arm and the chassis, a jack must be positioned under the lower control arm to unload the ball joints.

Do not place the safety stands under the frame to check for play in the load-carrying ball joint because the front spring tension would make it impossible to measure actual free play. Placing the safety stands under the lower arms on a front-wheel-drive vehicle would make ball joint free play impossible to measure because the ball joints would be supporting the weight of the front of the vehicle.

**Task  
B.1.5****Inspect and replace kingpins, bearings, and bushings.**

Monobeam suspensions are found on some pickup trucks. This suspension system is made up of a single I-beam sold axle. The wheel spindle is attached to the I-beam by a kingpin and some bushings. This allows for the turning of the front wheels. The kingpin is held to the axle by a lock bolt or pin.

**Task  
B.1.6****Inspect and replace steering knuckle/spindle assemblies and steering arms.**

Excessive tire squeal while cornering may be caused by improper toe-out on turns. This problem can be caused by a bent steering arm. Bent steering arms and steering knuckles or spindles show up in the alignment readings for toe-out on turns and in the steering axis inclination readings. Sometimes a technician can see rust flakes or disturbed metal at the bent section of the part. The parts named must be replaced if they are bent or otherwise damaged.

**Task  
B.1.7****Inspect and replace front suspension system coil springs and spring insulators (silencers).**

Inspect springs for signs of excessive wear and indications of cracking. Check for signs of coil spring interference. If a problem exists, it may be corrected by installing upper coil springs spacers on top of the coil spring. Spring removal is required to install these spacers.

While using a spring compressor to remove a coil spring from a strut, the spring should be taped in the spring compressor contact areas, and all the spring tension must be removed from the upper strut mount before loosening the strut rod nut.

The vehicle manufacturer often puts a stronger spring on one side of the vehicle because of weight differences, but sometimes the manufacturer puts the same strength spring on both sides.

Most vehicles have a silencer pad between the spring and the chassis. If one of the silencer pads was left off, the vehicle would lean to that side, and there would probably be noises coming from that location.

To remove the coil spring from the suspension, it must be compressed with a coil spring compressor. Always follow the manufacturer's directions for the proper operation and attachment of the coil spring compressor. The shock often must be removed to install the spring compressor. With the spring compressed, the control arm can be disconnected and lowered to remove the spring.

### **Task B.1.8**

#### **Inspect and replace front suspension system leaf spring(s), leaf spring insulators (silencers), shackles, bushings, brackets, and mounts.**

Removing and replacing front leaf springs are basic mechanical repair operations. Generally, leaf springs are replaced only when a leaf is broken or when they sag noticeably.

A leaf spring is mounted with a rubber bushing and bolt through the eye at one end and by rubber bushings and bolts on shackles at the other end. The shackles at one end of the spring let the spring length change as it flexes. If the spring were mounted directly to the frame at both ends, it would bind and eventually break.

Inspect shackles and bolts for damage and excessive wear. Inspect rubber bushings for wear, deterioration, and damage from grease and oil. Special removal and installation tools often make bushing replacement easier.

### **Task B.1.9**

#### **Inspect, replace, and adjust front suspension system torsion bars; inspect mounts.**

Removing and replacing torsion bars, like springs, are basic repair operations. Torsion bars also are generally replaced only when damaged. Unlike coil and leaf springs, torsion bar stiffness is adjustable on the vehicle, and this is what establishes the ride height of the vehicle.

One end of the torsion bar is splined or clamped to a suspension control arm. The other end is secured in a bracket on the chassis. The chassis end of the torsion bar has a short arm and adjusting bolt to set ride height and bar stiffness. Checking the ride height and adjusting it if necessary is a basic part of wheel alignment service. Car-makers' ride height specifications and measurement points vary, so you should check manufacturers' instructions and specifications for this procedure.

### **Task B.1.10**

#### **Inspect and replace stabilizer bar (sway bar) bushings, brackets, and links.**

Stabilizer bars—also called antiroll bars or sway bars—minimize body roll, or sway, during cornering. Stabilizer bars do not affect spring stiffness or vehicle spring rate, ride height, or shock absorber action. A stabilizer is mounted in brackets with bushings on the car underbody or frame. Links attach each end of the bar to the front or rear control arms or axle housing. During cornering, the bar and its links transfer vehicle loads from the inside to the outside of the suspension. This reduces the tendency of the outside suspension to lift and thus reduces body roll.

The rubber bushings on stabilizer bars and links tend to deteriorate over time and also can be damaged by grease and oil. Worn or damaged bushings should be replaced. Mounting bolts and link bolts may become loose and occasionally break. These should be tightened or replaced as necessary.

### **Task B.1.11**

#### **Inspect and replace strut cartridge or assembly.**

A new cartridge may be installed in some front struts with the strut installed in the vehicle. Other struts must be removed to allow cartridge installation. Prior to strut removal from the vehicle, the upper strut mounting nuts and the strut-to-steering knuckle bolts must be removed. A spring compressor must be used to compress the spring before the spring is removed from the strut.

MacPherson struts are not only a suspension part, but also serve as a shock absorber and help control vehicle bounce. When replacing just the cartridge and not the outside

housing, oil is left in the old housing to help transfer heat. Upper strut support plates and bearings cause noises.

### **Task**

#### **B.1.12**

**Inspect and replace strut bearing and mount.**

A defective upper strut mount may result in strut chatter while cornering, poor steering wheel return, and improper camber or caster angles on the front suspension.

The caster and camber adjuster plates would make noise if someone had left the bolts loose. The bearings and support plates support the weight of the front of the chassis, the engine, and the transaxle, and have to withstand the weight-shifting forces of braking and the rotating forces of steering the vehicle.

## **2. Rear Suspensions (5 Questions)**

### **Task**

#### **B.2.1**

**Diagnose rear suspension system noises, body sway/roll, and ride height problems; determine needed repairs.**

A squeaking noise in the rear suspension may be caused by suspension bushings, defective struts or shock absorbers, or broken springs or spring insulators. Harsh riding may be caused by reduced rear suspension ride height and defective struts or shock absorbers.

Excessive rear suspension oscillations may be caused by defective struts. Weak coil springs cause harsh riding and reduced ride height. Broken springs or spring insulators cause a rattling noise while driving on irregular road surfaces. Worn-out struts or shock absorbers result in chassis oscillation and harsh riding.

A broken spring leaf will cause the vehicle to lean toward the broken side. Missing insulators will cause creaking and squeaking noises, not rattles, as the suspension moves up and down. Worn shackle bushings or worn shackles will cause rattles when the vehicle is driven over road irregularities at low speeds. Broken center bolts will allow one side of the axle or housing to move forward or rearward.

Sway bars are not likely to cause vibrations. Coil springs with a high load rating could cause the vehicle to be too high in the rear.

If the rear strut cartridge is weak, the vehicle would bounce more than normal in the rear, but should not hit bottom going over speed bumps at low speeds. If the rear springs are weak, the chassis will hit bottom easily.

### **Task**

#### **B.2.2**

**Inspect and replace rear suspension system coil springs and spring insulators (silencers).**

When replacing rear coil springs, the old spring ends should be matched with the new springs. Matching the spring ends will ensure that the springs are installed correctly. Linear-rate springs or variable-rate springs may be used. Linear-rate springs have equal spacing between the coils and are available as heavy-duty springs for most applications. Variable-rate springs typically have coils spaced closer together at the top with more space between the coils at the bottom of the spring. Variable-rate springs provide automatic load adjustment while maintaining vehicle height.

### **Task**

#### **B.2.3**

**Inspect and replace rear suspension system lateral links/arms (track bars), control (trailing) arms, stabilizer bars (sway bars), bushings, and mounts.**

On some rear suspension systems, the lower control arm bolts must be torqued with the vehicle weight on the suspension. If the rear suspension bolts are tightened while the suspension parts are extended down on a frame contact hoist, the bushings will have a short life. Once the vehicle is lowered, the bushings, instead of the springs, will be supporting the body weight. If the vehicle is lowered to the floor, many of the bolts will be inaccessible. It is much better to put the vehicle on an alignment rack for the final tightening.

**Task  
B.2.4**      **Inspect and replace rear suspension system leaf spring(s), leaf spring insulators (silencers), shackles, brackets, bushings, and mounts.**

A sagging left rear leaf spring lowers the left rear ride height and increases the positive caster on the left front wheel. Since the steering pulls to the side with the least positive caster, this problem may cause steering pull to the right.

All leaf springs have a bolt or rivet near the center to index with a hole or depression in the housing. This ensures that the rear wheels remain correctly positioned. If the center bolt breaks or if the spring shackles are loose, the spring will shift on the housing and the vehicle will no longer track properly.

**Task  
B.2.5**      **Inspect and replace rear strut cartridge or assembly and upper mount assembly.**

Rear struts are serviced similarly to front struts, except that rear struts do not have a steering knuckle to deal with. The coil spring on the strut must be compressed to separate it from the strut assembly. Some struts can be serviced by replacing an internal cartridge that contains the shock absorber. Others require replacement of the entire strut.

When reassembling the strut, be sure that the spring is seated securely in its mounting brackets. Inspect the upper mounting location on the car body. Replace any worn or damaged fasteners or other parts. If the body structure is damaged, more extensive repairs will be required.

**Task  
B.2.6**      **Inspect non-independent rear axle assembly for bending, warpage, and misalignment.**

A non-independent rear axle may be checked for bending, warpage, and misalignment by measuring the rear wheel tracking. This operation may be performed with a track bar or computer wheel aligner with four-wheel capabilities. A track bar measures the position of the rear wheels in relation to the front wheels. A computer wheel aligner displays the thrust angle, which is the difference between the vehicle thrust line and geometric centerline of the vehicle. Rear axle offset may cause steering pull.

**Task  
B.2.7**      **Inspect and replace rear ball joints and tie rod/toe link assemblies.**

Many ball joints have a wear indicator. In these ball joints, the shoulder of the grease fitting must extend a specific distance from the ball joint housing. If this distance is less than specified, the ball joint must be replaced. There is no clearance between the grease fitting shoulder and the ball joint housing.

A worn ball joint may cause improper position of the lower end of the rear knuckle, wheel hub, and wheel. This action may result in improper rear wheel camber.

If a rear wheel tie rod is longer than specified, the rear wheel toe-out will be excessive. The length of the tie rod determines the rear wheel toe setting.

Rear load-carrying and non-load-carrying ball joints are tested like the front ball joints. Rear tie rod ends are checked the same as front tie rod ends. The rear ball joints and rear tie rod ends usually last much longer than the front because the rear does not rotate and these components carry much less weight. Some rear ball joints and rear tie rod ends have to be lubricated.

**Task  
B.2.8**      **Inspect and replace knuckle/spindle assembly.**

The steering knuckle or wheel spindle is the mounting point for the wheel and brake assemblies. The wheel rotates on the spindle via a set of bearings. If the bearings go bad or if the bearings have not been lubricated properly, the spindle can wear or break. The steering knuckle/spindle is held in place by control arms and/or the suspension strut. To replace a knuckle/spindle, the wheel assembly must be removed and the ball joints, control arms, steering linkage, springs, and/or strut assembly must be disconnected from the spindle assembly. After reinstallation, the wheels must be aligned.

### 3. Miscellaneous Service (2 Questions)

#### Task B.3.1

#### Inspect and replace shock absorbers, mounts, and bushings.

When one side of the bumper is pushed downward with considerable force and then released, the bumper should only complete one free upward bounce if the shock absorber or strut is satisfactory. More than one free upward bounce indicates defective shock absorbers, loose shock absorber mountings, or defective struts.

Shocks should be inspected for oil leakage. If oil is dripping from the shock, replace it. A light film of oil is acceptable on the piston rod and lower chamber. If more than a light film is present the shock should be replaced.

The procedure to remove a rear shock absorber is:

1. Lift the vehicle on a hoist and support the rear axle on safety stands so the shock absorbers are not fully extended.
2. Disconnect the upper shock mounting nut and grommet.
3. Remove the lower shock mounting nut or bolts.
4. Remove the shock absorber.

#### Task B.3.2

#### Inspect and replace air shock absorbers, lines, and fittings.

Some air shock absorbers can be pressurized with the shop air. If air shock absorbers slowly lose their pressure and reduce ride height, shock absorber replacement is probably necessary.

Not all systems are built to operate with the same pressures. Fifty psi (345 kPa) air pressure should be enough pressure to test any system. Some air shock systems are not designed to operate with 100 psi (690 kPa) air pressure. If excessive pressure is introduced into the system, the shock absorber bladder may rupture. The lines are easily destroyed if they are too close to hot exhaust system parts and must be secured with plastic ties so they do not get pinched between the chassis and the suspension parts.

#### Task B.3.3

#### Diagnose and service front and/or rear wheel bearings.

Loose front wheel bearings may cause steering wander. When two tapered roller bearings are mounted in the front or rear wheel hub, a typical bearing adjustment procedure is as follows:

- Tighten the bearing adjustment nut to 17 to 25 ft. lbs. (23 to 34 Nm).
- Back off the adjustment nut one-half turn.
- Tighten the bearing adjustment nut to 10 to 15 ft. lbs. (14 to 20 Nm).
- Check the wheel bearing for free play.

If metal flakes are found in the grease near the bearing rollers, or race, the bearing and the race must be replaced. The other bearings can be reused if they rotate smoothly and have no pits or other defects. Bearings last a long time if they are properly lubricated and adjusted.

#### Task B.3.4

#### Diagnose, inspect, adjust, repair, or replace components of electronically controlled suspension systems, including primary and supplemental air suspension and ride control systems.

Once the air suspension system has been shut down for an hour, it becomes inactive. If there are leaks, as the air cools the vehicle height lowers. It is normal for an air suspension system to drop a little overnight, especially when there is a significant temperature change. If the system is functioning properly, the vehicle will level itself soon after startup. Most air suspension systems, both primary and supplemental, are automatic and have height level sensors, air control solenoids, relays, an electric air pump, and a module to make the system work. Most systems will store fault codes to help with diagnosis, and some systems have a function test that allows each corner of the vehicle to be raised and lowered to verify operation.

Use a scan tool for diagnosing the electronic suspension. Refer to the scan tool manufacturer's instructions for specific information.

### **Task B.3.5**

#### **Inspect and repair front and/or rear cradle (crossmember/subframe) mountings, bushings, brackets, and bolts.**

On unibody vehicles, a subframe is used to help support and locate the drivetrain. On vehicles with a frame and some unibody vehicles, a crossmember is used to support the engine and/or transmission. Proper alignment of the drive train is critical to the handling of the vehicle and the operation of many systems of the vehicle. As an example, if the crossmember or subframe is not secure to the vehicle or if the mounting's bushings are worn, the driver may experience shifting problems due to the misalignment of the shift linkage.

When servicing these units, the weight of the engine and/or transmission must be relieved before performing any service. This is often done by securing the engine on a hoist.

### **C. Wheel Alignment Diagnosis, Adjustment, and Repair (12 Questions)**

### **Task C.1**

#### **Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return problems; determine needed repairs.**

A broken center bolt in a left rear spring can cause rear axle offset, and this problem may cause steering pull to one side. Since the steering pulls to the side with the least positive caster, excessive positive caster on the left front wheel may cause steering pull to the right. Low tire pressure on the right front will cause the vehicle to pull to the right. Excessive front wheel toe-in causes feathered tire wear, but this problem does not affect steering pull. Steering axis inclination (SAI) or toe-out on turns does not affect steering pull while driving straight ahead. The steering tends to pull to the side with the most positive camber.

A proper alignment is done with the vehicle at the correct ride height. Setting the caster, camber, and toe without correcting improper ride height will not cure tire wear and handling problems. Ride height is especially important on a front-wheel-drive vehicle because if there is too much angle at the constant velocity joints of the drive axles, there will be annoying vibrations, especially during acceleration. All steering linkage parts, except the idler arm, call for zero free play and should be replaced if any looseness is felt or measured during inspection. If the vehicle has rear wheel steering, the rear alignment must be correct before any corrections are made in the front. The rear steering system must remain in its centered position while the front adjustments are being checked and adjusted. Not setting the idler arm adjustment properly can cause vibrations and shorten tire life.

A defective steering box or rack and pinion can cause steering problems, but the most likely problem would be loss of assist in both directions. Sometimes the control valve or its seals can cause a problem with assist in one direction.

Torque steer is the movement of the vehicle to one side of the travel lane during acceleration. This is due mostly to unequal forces transmitted from the drive train through unequal length drive axles on front-wheel-drive vehicles.

Bump steer is a condition usually caused by the rack shifting in its bushings when the vehicle hits a hole or bump on the roadway. The rack is held temporarily in that position off-center, and that causes the vehicle to steer sharply to one side after the rough spot is cleared.



Memory steer is a term used when the vehicle continues to pull or steer itself in the same direction as the last sharp turn. Memory steer is usually caused by tie rod ends that have lost their resiliency. The rubberized material that is supposed to help return the steering to center slips a little and its new position is its working center; it “remembers” it made a hard turn and keeps wanting to go in that direction.

## **Task C.2**

### **Measure vehicle ride height; determine needed repairs.**

Vehicle ride height is an important specification for wheel alignment on many vehicles. Ride height is usually adjustable on a vehicle with torsion bars, and this specification should be checked and adjusted before any other alignment measurements or adjustments.

Ride height can vary significantly on a single model of a light truck with various spring and wheel-and-tire combinations. As ride height varies, so does the front caster angle. Many trucks have different caster specifications for different ride heights. Most truck manufacturers publish tables of varying ride height specifications, which should be checked during any alignment operation.

Ride height measurement points vary from one vehicle to another. Some are measured between the lower control arm and the ground. Others are measured between a point on the fenderwell or under body and ground. Always verify the vehicle manufacturer’s measurement points, as well as the specifications.

If ride height is out of limits on a vehicle with torsion bars, it usually can be adjusted. If ride height is out of limits on a vehicle with coil or leaf springs, the springs or other suspension parts may require replacement.

Most vehicle manufacturers call for wheel alignment adjustments with the vehicle unloaded and at a specified ride height. Some carmakers, however, specify precise weight loads to be placed in a car during alignment. Trucks are often aligned with specified loads installed if they are part of normal vehicle operation.

## **Task C.3**

### **Check and adjust front and rear wheel camber on suspension systems with a camber adjustment.**

Vehicle manufacturers provide many different ways to adjust front and rear camber:

- Shims may be placed between various suspension components and the frame. (Shims are usually used between control arm pivot shafts and their mounting brackets on the frame.)
- An eccentric cam lobe may be turned to move the control arm pivot point inward or outward on the chassis.
- Adjusting sleeves on control arm linkage.
- Adjusting strut rods.
- Moving strut mounts.
- Loosening and repositioning control arm mounting brackets on the frame.

Vehicle manufacturers publish wheel alignment specifications annually, and most computerized alignment equipment contains an onboard database of specifications and adjustment instructions.

Some vehicles have slightly more positive camber on the left front wheel than on the right to minimize vehicle pull caused by the crown of the road. More often, however, road crown compensation is done with slightly different caster angles.

Front wheel camber and caster are adjusted simultaneously on most vehicles that provide adjustment. Before adjusting camber and caster, jounce the vehicle to relieve any binding or stress on suspension parts and let it settle at its normal ride height. When either angle is adjusted, the other should be checked because changing one will affect the other. The front wheel toe angle is adjusted after caster and camber adjustments are done.

**Task  
C.4**      **Check front and rear wheel camber on nonadjustable suspension systems; determine needed repairs.**

If camber is not adjustable, the camber angle should still be checked to be sure it is within specifications. Most manufacturers publish specifications for the steering axis inclination (SAI), as well as the camber angle. SAI is the angle through the upper and lower ball joints or other pivot points compared with actual vertical. The “included angle” is the combination of SAI and camber. Positive camber is added to SAI to determine the included angle; negative camber is subtracted. By measuring camber and comparing it to SAI and included-angle specifications, you can determine if suspension parts are worn or damaged. If camber cannot be adjusted, components may need replacement.

**Task  
C.5**      **Check and adjust caster on suspension systems with a caster adjustment.**

The caster angle of the front wheels is measured by turning the front wheels a specified number of degrees left and right on the turnplates of the alignment rack. Caster is normally measured after the front camber and toe angle are measured. The brake pedal should be held down with a pedal depressor during caster measurement so that the vehicle will not roll on the rack as the wheels are turned. If the vehicle moves during caster measurement, the readings will be inaccurate.

Caster adjustments are usually made by the same methods as camber adjustments. Refer to the explanation for task 3, above. Refer to the explanation for task 6, below, for a discussion of caster differential to compensate for vehicle pull due to the crown of a road.

**Task  
C.6**      **Check caster on nonadjustable suspension systems; determine needed repairs.**

Most manufacturers specify less caster on the left side of the vehicle to make up for the crown of the road. More right caster helps the vehicle go straight even though most roadways are built about 3 or 4 inches (76 or 102 mm) lower on the curb side for drainage. If the caster is set exactly the same on both front wheels, the vehicle will probably pull to the right.

**Task  
C.7**      **Check and adjust front wheel toe.**

When front toe is measured, the front wheels must be straight ahead. After the toe adjustment is complete, the steering wheel must be centered with the front wheels straight ahead. A tie rod rotating tool must be used to rotate the tie rod sleeves. The front wheel toe should be measured after the caster measurement and adjustment.

Most rear-drive vehicles are built with tie rod adjuster sleeves with a right-hand thread on one side and a left-hand thread on the other side. On front-wheel-drive vehicles, it is rarely possible to center the steering wheel by turning both adjusters in the same direction.

**Task  
C.8**      **Center steering wheel.**

If the steering wheel spoke is 2 inches (50.8 mm) low on the left side while driving the vehicle straight ahead, the left tie rod should be shortened and the right tie rod lengthened. A one-quarter turn on the tie rod sleeves moves the steering wheel about 1 inch (25.4 mm).

**Task  
C.9**      **Check toe-out on turns (turning radius/angle); determine needed repairs.**

On many steering systems, the turning radius of the wheel on the inside of the turn is several degrees more than the turning radius on the outside of the turn. When the turning radius is not within specifications, a steering arm may be bent or a tie rod end may be loose.

**Task C.10**      **Check SAI/KPI (steering axis inclination/king pin inclination); determine needed repairs.**

When included angles on the front wheels have three degrees difference, the steering axis inclination (SAI) angle is probably improper on one of the front wheels. Improper SAI may be caused by an improperly positioned strut tower or engine cradle. There may be a slight pull when accelerating and braking.

SAI differences over three degrees will cause handling problems such as steering pull during braking and accelerating. It is the SAI angle, plus the camber angle readings, that the technician uses to determine whether there is frame or strut damage.

The front wheel or four-wheel alignment measurement will need to be done to determine frame, chassis, or strut damage if the technician finds a steering or acceleration pull during the post-alignment road test. Negative camber is subtracted from SAI to determine included angle. Positive camber is added to SAI to determine included angle. If there is more than 1½-degree difference from the right to left side, the vehicle will probably have a steering pull on acceleration or braking.

**Task C.11**      **Check included angle; determine needed repairs.****Task C.12**      **Check rear wheel toe; determine needed repairs or adjustments.**

Excessive toe-out on the left rear wheel may be corrected by installing a thinner shim on the front spindle bolts. Excessive toe-out on the left rear wheel may cause a steering pull to the right.

There is no caster adjustment on the rear wheels. Camber is adjusted before thrust line and toe on rear wheels. Camber is adjusted first when doing a four-wheel alignment. Then, thrust line is addressed while setting rear toe. Toe is always done last because it causes the most tire wear if wrong. If rear toe were set before rear camber the toe settings would change when the camber adjusters are moved.

**Task C.13**      **Check rear wheel thrust angle; determine needed repairs or adjustments.**

The thrust angle is the angle between the thrust line and the geometric centerline of the vehicle. If the thrust angle is excessive and the thrust line is positioned to the left of the geometric centerline, the left rear wheel may have excessive toe-out.

A thorough inspection is necessary and will often find damaged parts causing a problem. If an inspection does not reveal the cause of the tire wear, the next step is to use four-wheel alignment equipment to check thrust line, camber, and toe settings of the rear wheels. Non-independent rear axle assemblies are prone to bending and warpage by towing equipment and floor jacking equipment.

When all four wheels are parallel to the geometric centerline, the thrust line is positioned at the geometric centerline and the rear wheels will track directly behind the front wheels. A line through the center of each tire would be at a right angle to the thrust line. The geometric centerline is not adjustable. The thrust line is adjustable.

**Task C.14**      **Check for front wheel setback; determine needed repairs or adjustments.**

Setback occurs when one front wheel is rearward in relation to the opposite front wheel. Front wheel setback is sometimes caused by collision damage. In other cases, it is designed into the vehicle.

It is possible for caster and camber adjustments to be within specification while the setback is excessive. In that case, the vehicle will pull to the side with the most setback because that side has a shorter wheelbase. Not all vehicles have setback; those that do, have it on the right side. Setback is used by some manufacturers to eliminate or minimize torque steer.

**Task  
C.15****Check front cradle (crossmember subframe) alignment; determine needed repairs or adjustments.**

The front cradle may be measured in various locations to verify a bent condition. Some cradles have an alignment hole that must be aligned with a matching hole in the chassis.

The subframe is a critical part of the vehicle suspension and affects the steering. It must be properly centered in its designated location before the mounting bolts are tightened. Vehicle collisions can cause damage to the subframe, which will show up as excessive setback. Subframes must be centered properly with the chassis before the bolts are torqued.

**D. Wheel and Tire Diagnosis and Repair (5 Questions)****Task  
D.1****Diagnose tire wear patterns; determine needed repairs.**

Feathered tire wear may be caused by improper toe adjustment. Wear on one side of the tire tread usually indicates an improper camber setting. Cupped tread wear may indicate improper wheel balance.

Reducing air pressure in one front tire may solve a pulling problem, but not the cause. That tire would now wear on both shoulders because of underinflation. Swapping the tires front to rear is a good way to identify a tire that was built incorrectly with the tread slightly off center. That tire should be replaced, but sometimes will function in the rear.

Tires wear excessively because the tire tread is not contacting the road surface properly. Alignment adjustments correct most of that problem. Normally, vehicles are aligned with no extra loads in the cargo area or passenger compartment. There are special circumstances, like overweight drivers or drivers who do not distribute cargo weight properly, that require the vehicle be similarly loaded while the alignment is made.

If the tire pressure is right, overloading the vehicle will cause the tires to wear on both shoulders, not across the whole tread like the toe wear pattern. Hard cornering will cause a wear pattern on the outside shoulders, not across the whole tire. When toe-out on turns is not right, the steering arms must be replaced; there is no adjustment.

The tire type and load rating information needed for comparison with the tires presently on the vehicle will be found on the tire information label. Tires with a low load rating will not have enough sidewall strength to maintain proper tread-to-road contact and will show improper wear. If tires with a lower speed or load rating than recommended by the manufacturer are installed on a vehicle and that vehicle exceeds the speed or load rating of those tires, a blowout can occur, causing serious damage and injury.

**Task  
D.2****Check tire condition, tread pattern, and size; check and adjust air pressure.**

Overinflation causes wear on the center of the tire tread, and underinflation causes wear on the edges of the tread. Underinflation may also cause wheel damage. Tire pressure should be adjusted when the tires are cool.

Station wagons, trucks, and utility vehicles commonly require more pressure in the rear tires because of the loads they carry and to minimize sway. Putting more air in the tires on one side of the vehicle is never recommended.

All air pressure specifications on passenger cars and trucks are to be measured while the tire is cold. A cold tire is one that has been driven less than three miles. If the tires have been driven for more than three miles, they must be allowed to cool for two to three hours. Always refer to the vehicle manufacturer's specifications for the tire inflation pressure.

**Task D.3 Diagnose wheel/tire vibration, shimmy, and noise problems; determine needed repairs.**

Front wheel shimmy may be caused by improper dynamic wheel balance, excessive positive caster, or loose steering linkage components.

**Task D.4 Rotate tires/wheels and torque fasteners according to manufacturers' recommendations.**

Most vehicle manufacturers recommend tire rotation at specified intervals to obtain maximum tire life. The exact tire rotation procedure depends on the model year, the type of tire, and whether the vehicle has a conventional or compact spare. For proper tire rotation procedures, refer to the vehicle manufacturer's service manual or owner's manual. There are several different recommended rotation patterns.

When rotating tires, inspect the sidewalls of the tires for directional indicators; some tires are designed to rotate in a specific direction. Directional tires are typically rotated front to rear to keep the tires rotating in the correct direction. Some vehicles have directional wheels that are designed to work only on one side or one location on the vehicle. Directional wheels need to be installed in the correct location to allow proper airflow, to keep the brakes at a normal operating temperature.

**Task D.5 Measure wheel, tire, axle flange, and hub runout (radial and lateral); determine needed repairs.**

Excessive rear chassis waddle may be caused by a shifted steel belt in a tire, or a bent rear hub flange. Tire and wheel runout can be checked by using a runout gauge that follows the tire tread (radial runout), or the gauge can be placed on the sidewall of the tire (lateral runout).

If the technician carefully checks runout of all of the parts involved and marks all of the high and low spots, he or she can correct excessive runout. New parts may not be necessary to correct the problem. Because front-wheel-drive cars are lighter and smaller, they transmit noises, vibrations, harshness, and out-of-round conditions more than larger rear-wheel-drive cars and trucks.

**Task D.6 Diagnose tire pull (lead) problems; determine corrective actions.**

Steering pull may be caused by front tires with different types, sizes, inflation pressure, or tread designs, or a front tire with a conicity defect.

Conicity is a term used in the tire industry when a tire bead is not centered on the tire body. The bead forms a cone, which causes the vehicle to pull in the direction of the small side of the cone. This condition is more commonly referred to by the technician as tire lead. An out-of-round condition will cause that corner of the vehicle to have a lot of up-and-down motion. This is called wheel hop.

**Task D.7 Dismount and mount tire on wheel.**

Tires are mounted and dismounted from a wheel using a tire changer. A good tire changer allows the tire to be removed without damaging the tire's beads or the edges of the wheel.

**Task D.8 Balance wheel and tire assembly (static and/or dynamic).**

Dynamic wheel balance refers to the balance of a wheel in motion. Cupped tire treads, wheel shimmy, or excessive steering linkage wear may be caused by dynamic wheel imbalance.

A wheel and tire assembly that is statically unbalanced will bounce up and down. A wheel and tire assembly that is dynamically unbalanced will cause the wheel to shake from side to side. This is called a shimmy.



# 5

## Sample Test for Practice

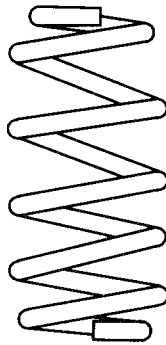
### Sample Test

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*Please note the letter and number in parentheses following each question. They match the overview in section 4 that discusses the relevant subject matter. You may want to refer to the overview using this cross-referencing key to help with questions posing problems for you.*

1. To remove the power steering pump, which procedure should be done first?
  - A. Remove the hose from the pump, and cap the fittings and hoses.
  - B. Loosen the bracket, or belt tension adjusting bolt, and the pump mounting bolt. Remove the bolt.
  - C. Disconnect the power steering return hose from the remote reservoir or pump and allow the fluid to drain.
  - D. Remove the tension adjusting bolt and the mounting bolt and remove the pump. (A.2.6)
2. During rack-and-pinion steering gear service, Technician A says the inner tie rod end should be replaced if the articulation effort on this tie rod is less than specified. Technician B says the rack must be held while loosening the inner tie rod ends. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.9)
3. To remove the manual steering gear (non-rack-and-pinion type), which procedure should be done first?
  - A. Remove the steering gear from the chassis.
  - B. Disconnect the flexible coupling from the worm shaft.
  - C. Remove the steering-gear-to-frame mounting bolts.
  - D. Disconnect the battery ground cable. (A.1.5)
4. Technician A says front wheel setback is usually caused by worn suspension components. Technician B says a slight front wheel setback causes steering pull. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.14)

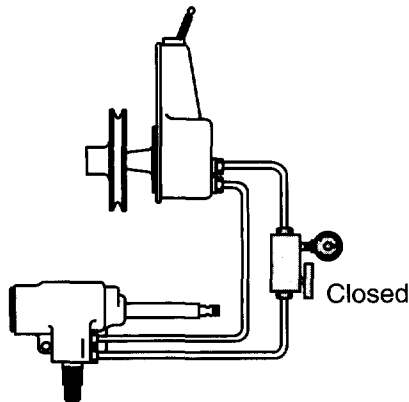
5. With the steering column mounted in the vehicle and all linkages connected, a steering wheel has 2.35 inches (59.7 mm) of free play. Technician A says the flexible coupling may be worn. Technician B says the steering gear mounting bolts may be loose. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.1)
6. A manual rack-and-pinion steering gear requires excessive steering effort. Technician A says the lower ball joints on the front suspension may be worn. Technician B says the rack bearing adjustment may be too tight. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.8)



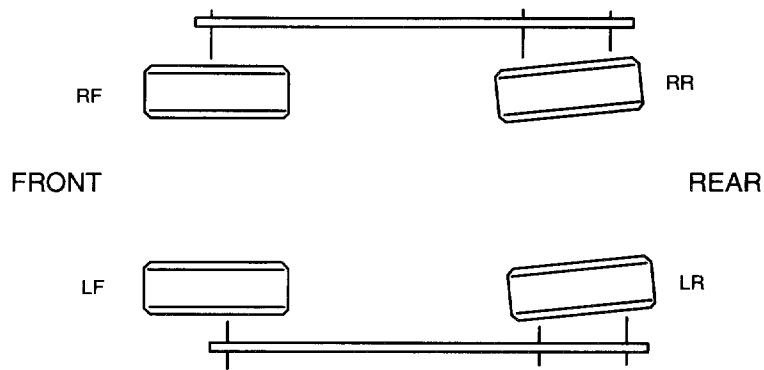
7. The coil spring shown is:
- A. a linear-rate spring.
  - B. a variable-rate spring.
  - C. a heavy-duty spring.
  - D. an adjustable spring.
- (B.2.2)
8. The steering pulls to the right while driving straight ahead on a truck with a long-and-short arm front suspension and a leaf spring rear suspension. All of the following defects could be the cause of the problem EXCEPT:
- A. a broken center bolt in the left rear spring.
  - B. more positive caster on the left front wheel than the right front wheel.
  - C. low tire pressure on the right side.
  - D. excessive toe-in on the front wheels.
- (C.1)
9. While discussing front cradle alignment, Technician A says the cradle may be measured at various locations to determine if it is bent. Technician B says on some cradles an alignment hole in the cradle must be aligned with a hole in the chassis. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.15, B.3.5)



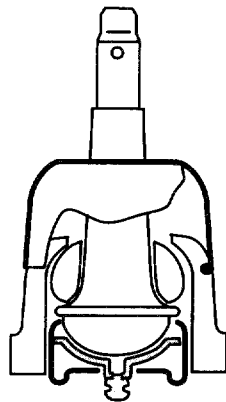
10. To remove the power steering gear (non-rack-and-pinion type), which procedure should be done first?
- A. Disconnect the steering gear shaft from the worm shaft.
  - B. Remove the Pitman arm nut and washer and mark the Pitman arm in relation to the shaft with a center punch.
  - C. Remove the steering gear mounting bolts and remove the steering gear from the chassis.
  - D. Disconnect the hoses from the steering gear, cap the lines, and cap the fittings. (A.2.10)
11. To remove the manual or power rack-and-pinion steering gear, which procedure should be done first?
- A. Remove cotter keys from the outer tie rod ends.
  - B. Punch mark the lower universal joint and the steering gear pinion shaft.
  - C. Remove the four stabilizer bar mounting bolts.
  - D. Remove the steering gear mounting bolts. (A.1.7)



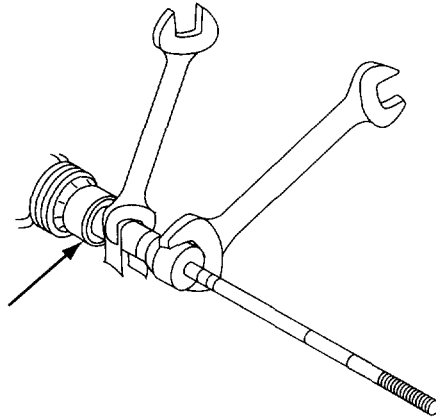
12. During the power steering pump pressure test shown, the pressure gauge valve should be closed for:
- A. 10 seconds.
  - B. 15 seconds.
  - C. 20 seconds.
  - D. 30 seconds. (A.2.9)
13. A power steering pump with an integral reservoir is leaking fluid between the reservoir and the pump housing. Technician A says the driveshaft seal may require replacement. Technician B says the fluid return hose may be restricted. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.5)
14. A front-wheel-drive vehicle has 3 degrees difference between the included angles on the left and right front wheels. This problem could be caused by:
- A. a bent engine cradle.
  - B. worn steering gear mounting bushings.
  - C. loose front wheel bearings.
  - D. loose inner tie rod ends. (C.11)



15. A non-independent rear axle is offset as shown in the figure. This problem could result in:
- A. steering wander while driving straight ahead.
  - B. steering pull to the right while driving straight ahead.
  - C. poor steering wheel returnability.
  - D. steering pull to the left during hard acceleration. (B.2.6)
16. Excessive looseness is experienced in a power steering gear (non-rack-and-pinion type). The cause of this problem could be a:
- A. loose or worn power steering belt.
  - B. loose worm shaft bearing preload adjustment.
  - C. scored steering gear cylinder.
  - D. low fluid level in the power steering pump. (A.2.1)

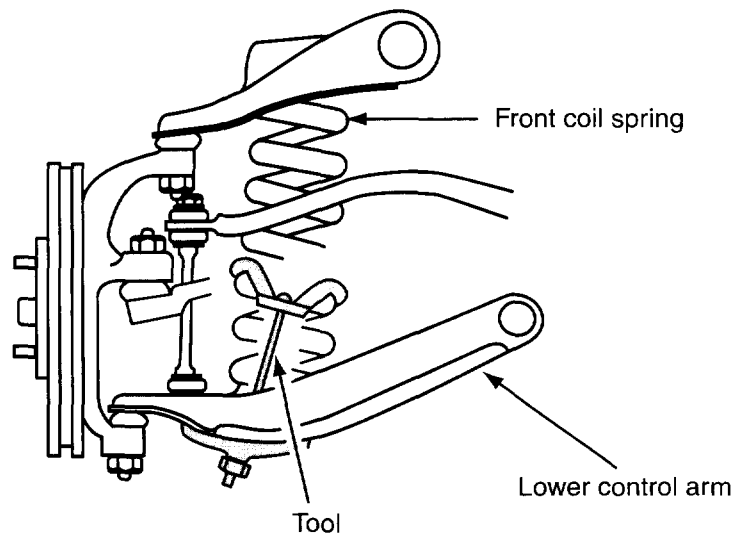


17. While servicing a suspension system as shown, Technician A says the ball joint nut may be loosened to align the cotter pin hole with the nut castellations. Technician B says the lower control arm retaining bolts should be torqued with the vehicle weight on the suspension. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.2.2)



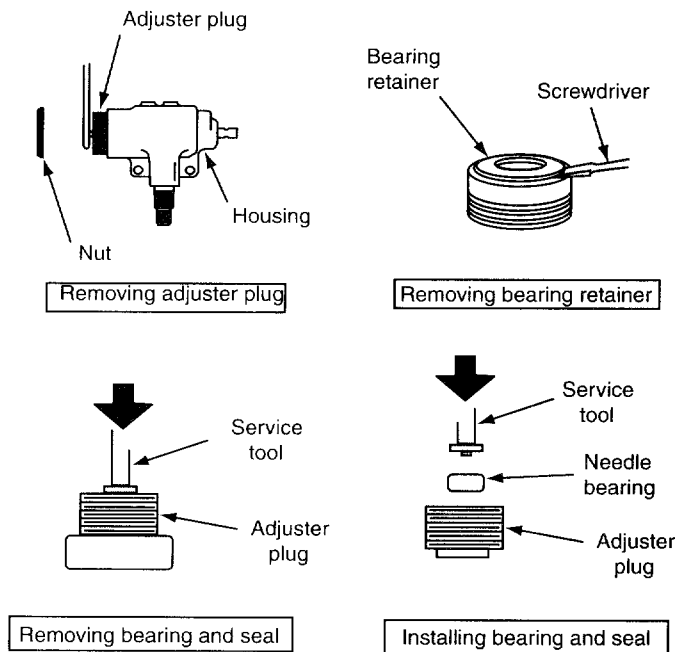
18. In the figure, the component indicated by the arrow is a:
- A. spacer.
  - B. rack bushing.
  - C. shock dampener.
  - D. rack seal.
- (A.3.5)

19. A customer complains about steering chatter while cornering with a MacPherson strut front suspension system. With the vehicle parked on the shop floor, the technician can feel a binding and releasing action on the left front spring as the steering wheel is turned. Technician A says the upper strut mount may be defective. Technician B says the lower ball joint may have excessive wear. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.12)



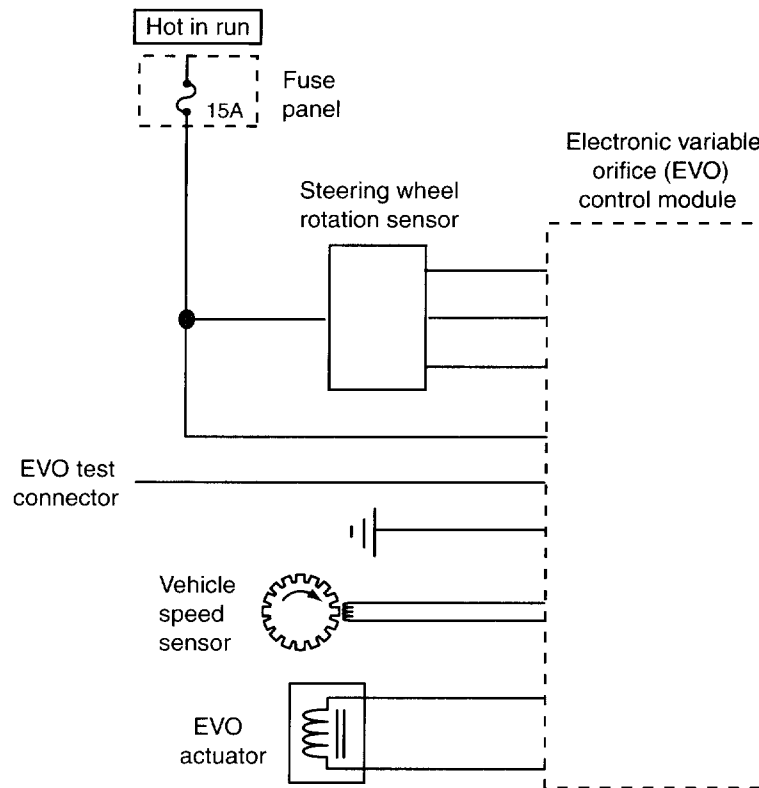
20. The tool shown is used to:
- A. compress the coil spring.
  - B. position the shock absorber rod.
  - C. measure ball joint movement.
  - D. measure lower control arm bushing wear.
- (B.1.7)

21. All of the following statements about tire inflation are true EXCEPT:
- A. Overinflation causes excessive wear on the center of the tread.
  - B. Underinflation causes excessive wear on both edges of the tread.
  - C. Tire pressure should be adjusted when the tires are hot.
  - D. Underinflation may cause tire and/or wheel damage. (D.2)
22. A vehicle has excessive body sway while cornering. All of the following defects could be the cause of the problem EXCEPT:
- A. a worn strut rod bushing.
  - B. a weak stabilizer bar.
  - C. a worn stabilizer bar bushing.
  - D. a broken stabilizer link. (B.1.1)
23. While discussing air shock absorbers, Technician A says that some air shock absorbers can be pressurized with a shop air hose. Technician B says if a shock absorber slowly loses its air pressure, shock absorber replacement may be necessary. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.3.2)



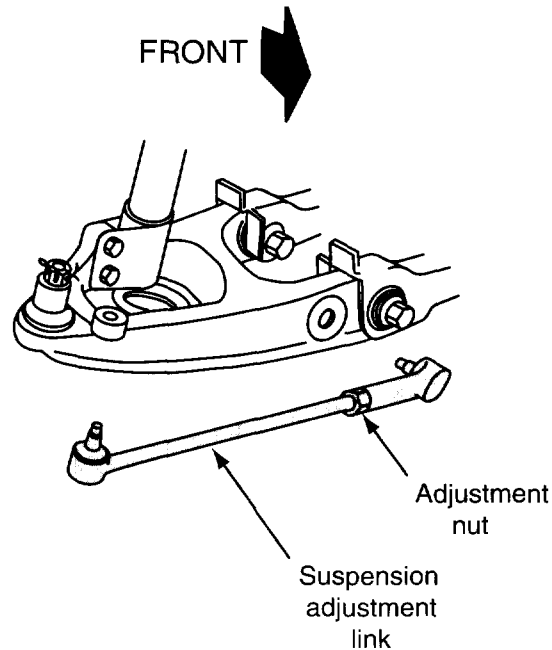
24. When servicing the bearing and seal in the adjuster plug of the power steering gear (non-rack-and-pinion type) shown, Technician A says that when installing the bearing, the part number on the needle bearing should face the driving tool. Technician B says the worm shaft bearing preload must be adjusted after the bearing and seal installation in the adjuster plug. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.13)

25. Poor steering wheel returnability is experienced on a rack-and-pinion steering gear. Technician A says the steering gear may be misaligned on the chassis. Technician B says the rack bearing adjustment may be too tight. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.8)
26. When an electronically controlled four-wheel-steering (4WS) system enters the fail-safe mode:
- A. voltage is maintained to the rear steering unit.
  - B. the control unit deenergizes the damper relay.
  - C. the rear steering unit moves rapidly to the center position.
  - D. the 4WS lamp is lit on the instrument panel.
- (A.2.1)
27. While bleeding air from a power steering system, Technician A says if foaming is present in the reservoir after the bleeding process, the bleeding procedure should be repeated. Technician B says each time the steering wheel is rotated fully right or left, it should be held in this position for two or three seconds. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.17)
28. On a torsion bar front suspension system, the ride height is below specifications on the right front side of the chassis. The ride height is satisfactory on the left front side of the chassis. Technician A says the right side lower control arm bushing may be worn. Technician B says the right front torsion bar anchor bolt may need adjusting. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.2)

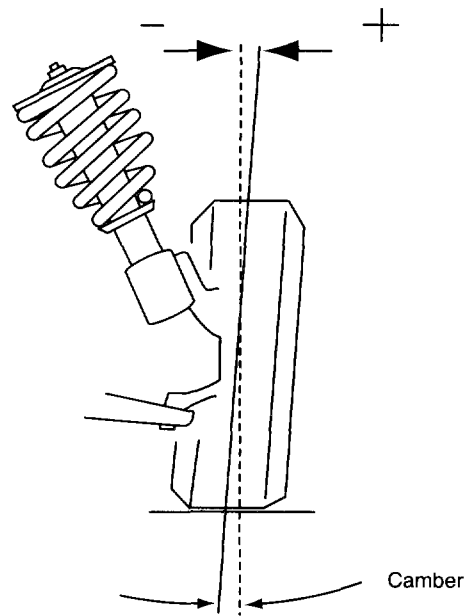


29. In the variable-assist power steering system shown, Technician A says the power steering assist is increased at speeds above 50 mph (80 km/h). Technician B says the power steering assist is increased when steering wheel rotation exceeds the specified limit. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.2.18)
30. The thrust angle on a front-wheel-drive vehicle is more than specified, and the thrust line is positioned to the left of the geometric centerline. This problem could be caused by excessive:
- toe-out on the left rear wheel.
  - toe-out on the right rear wheel.
  - positive camber on the left rear wheel.
  - wear in the left rear lower ball joint.
- (C.13)
31. When unloading the ball joints on a front suspension with the coil spring located between the lower control arm and the frame:
- a safety stand must be placed under the chassis.
  - the shock absorber must be disconnected.
  - the ride height must be within specifications.
  - a safety stand must be placed under the lower control arm.
- (B.1.4)

32. Bump steer is experienced during a road test for steering diagnosis. Technician A says the steering gear may require adjustment. Technician B says the Pitman arm may be bent. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.1, A.3.2)



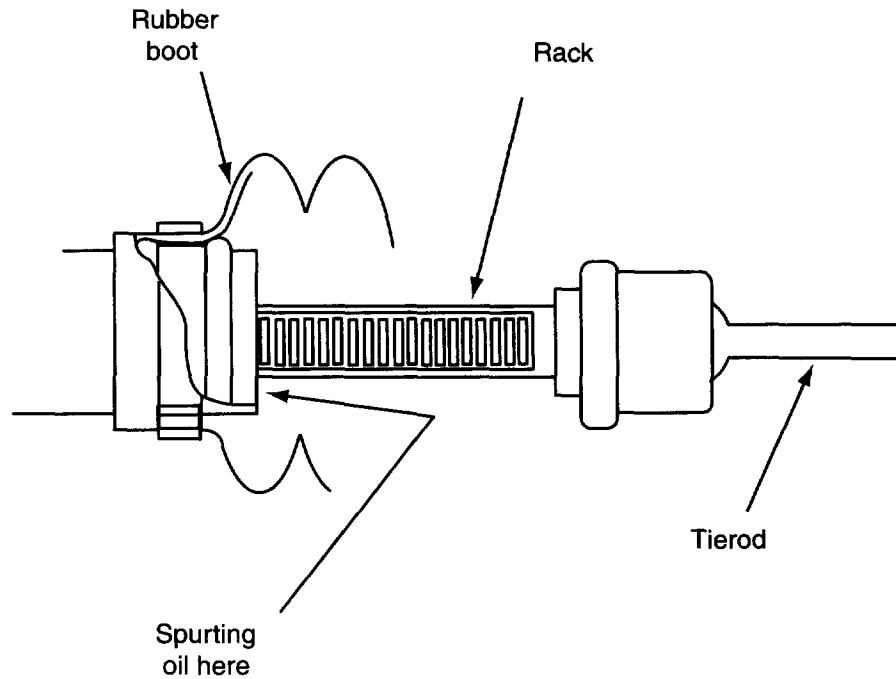
33. The left rear wheel tie rod shown is longer than specified. This problem could cause:
- A. excessive toe-out.
  - B. excessive positive camber.
  - C. excessive wear on the outside edge of the tread.
  - D. steering pull to the right.
- (B.2.7)
34. On a rear suspension with two longitudinally mounted leaf springs, the left rear spring is sagged and the left rear chassis ride height is less than specified. This problem could result in:
- A. steering pull to the right while driving straight ahead.
  - B. excessive left rear tire tread wear.
  - C. excessive steering wheel free play.
  - D. excessive left front tire tread wear.
- (B.2.4)
35. During a suspension inspection, the technician discovers a bent relay rod. Technician A says this problem changes the front wheel toe setting. Technician B says this problem may cause feather-edged front tire wear. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.3)



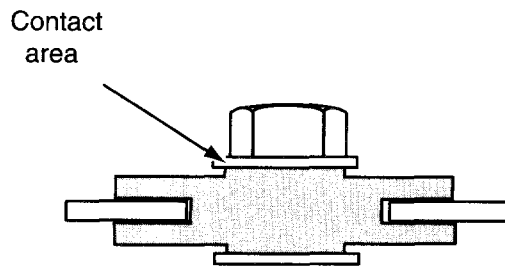
36. The rear suspension system shown requires a camber adjustment. Technician A says the lower strut to knuckle bolt hole on the strut may be elongated with a file to adjust camber. Technician B says the upper strut mount to body holes may be elongated to adjust the camber setting. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (C.4)
37. A front-wheel-drive vehicle has excessive toe-out on the left rear wheel. Adjustment shims are positioned between the rear spindles and the spindle mounting surfaces. Technician A says a thicker shim should be installed on the front bolts in the left rear spindle. Technician B says this problem may cause the steering to pull to the right. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (C.12)
38. A vehicle pulls to the right while braking, and all brake components are in good condition. Technician A says the right front strut rod bushing may be worn. Technician B says there may be excessive negative camber on the right front wheel. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (B.1.3)
39. Front wheel shimmy may be caused by:
- excessive toe-out.
  - improper dynamic wheel balance.
  - excessive front wheel setback.
  - excessive positive camber.
- (D.3)



40. A customer complains about harsh ride and bottoming of the rear suspension. Technician A says the rear struts may be defective. Technician B says the rear suspension ride height may be less than specified. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (B.2.1)
41. A vehicle requires excessive steering effort. The power steering belt is tight and the reservoir is filled to the specified level. The cause of this problem could be:
- worn lower ball joints.
  - weak front springs.
  - a seized idler arm.
  - a weak stabilizer bar.
- (A.3.4)

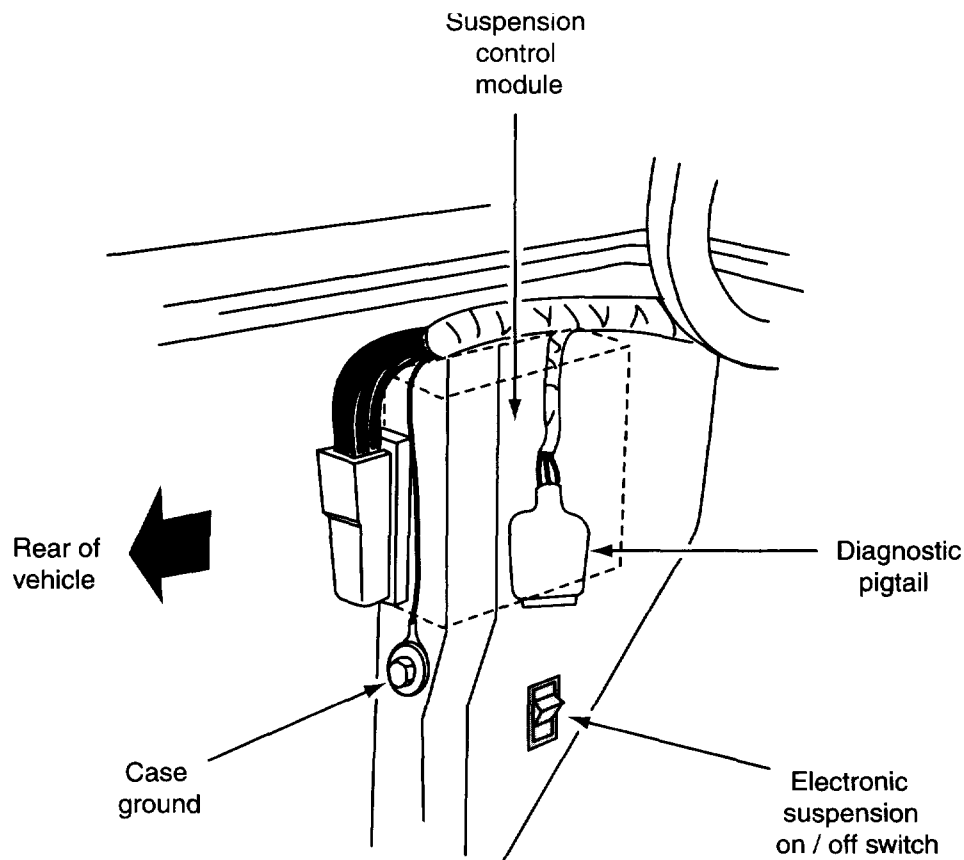


42. A power rack-and-pinion steering gear has a spurting oil leak, at the location shown, when the rack contacts the left inner stop. The cause of this problem could be a worn:
- inner rack seal.
  - pinion seal.
  - outer rack seal.
  - input shaft seal.
- (A.2.2)
43. The front suspension ride height is less than specified on a MacPherson strut suspension system. The cause of this problem could be any of the following EXCEPT:
- worn-out struts.
  - damaged upper strut mounts.
  - worn steering gear mounting bushings.
  - worn lower control arm bushings.
- (B.1.1)



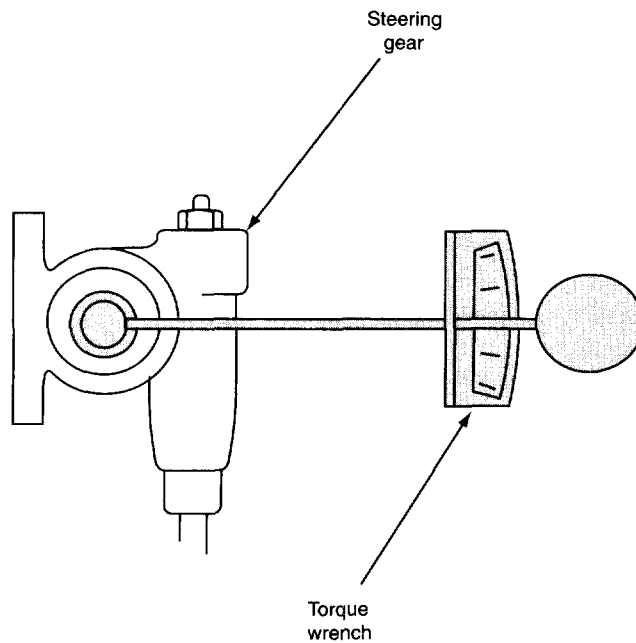
44. A mounting bolt of a collapsible steering column bracket is shown in the figure. Technician A says if the bolt head is touching the bracket, the bracket should be replaced. Technician B says if the bolt head is touching the bracket, the shear load is too low. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.1.4)
45. A vehicle pulls to the left while driving straight ahead. The cause of this problem could be:
- more positive camber on the left front wheel than the right front wheel.
  - more positive caster on the left front wheel than the right front wheel.
  - excessive toe-in.
  - improper toe-out on turns on the right front wheel.
- (C.1)
46. While discussing tie rod sleeve adjustments, Technician A says the tie rod sleeves may be rotated to adjust front wheel toe. Technician B says the tie rod sleeves may be rotated to center the steering wheel. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.3.5)
47. A four-wheel-drive (4WD) vehicle suffers excessive road shock at the steering wheel while driving on irregular road surfaces. Technician A says the power steering gear cylinder may be scored. Technician B says the steering damper may be worn out. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.3.6)
48. The steering on a car with a manual rack-and-pinion steering gear suddenly veers in one direction when one or both front wheels hit a bump. The cause of this problem could be:
- a loose steering gear mounting bushing.
  - excessive positive caster on both front wheels.
  - worn upper strut mounts.
  - worn-out front struts.
- (A.1.10)
49. The cause of poor returnability on a manual rack-and-pinion steering gear could be:
- a loose rack bearing adjustment.
  - insufficient or improper lubricant in the steering gear.
  - loose steering gear mounting bolts.
  - excessive positive camber on both front wheels.
- (A.1.3)

50. When checking the power steering pump belt tension, for every foot (30.5 cm) of free span, belt deflection should be:
- A. 0.5 inch (12.7 mm).
  - B. 1 inch (25.4 mm).
  - C. 1.5 inch (38.1 mm).
  - D. 1.75 inch (44.4 mm).
- (A.2.4)
51. During a power steering pump pressure test, the pump pressure is satisfactory but the steering wheel turning effort is excessive. Technician A says the steering gear may be defective. Technician B says the high-pressure hose may be restricted. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.9)



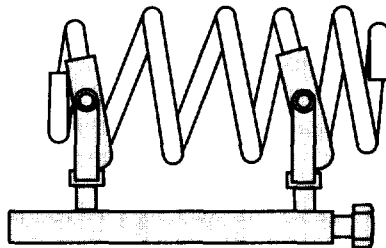
52. The electronic suspension switch shown must be in the off position under all the following conditions EXCEPT while:
- A. diagnosing the system with a scan tester.
  - B. jacking the vehicle to change a tire.
  - C. hoisting the vehicle for under-car service.
  - D. towing the vehicle with a tow truck.
- (B.3.4)

53. All of the following statements about caster adjustment are true EXCEPT:
- The caster angle is measured with the front wheels straight ahead.
  - The front wheels are turned a specified number of degrees left and right to read the caster angle.
  - The brakes must be applied with a brake pedal depressor before reading the caster angle.
  - The front suspension should be jounced several times before reading the caster angle. (C.5)
54. A vehicle has excessive rear suspension oscillations. Technician A says the rear struts may be defective. Technician B says the rear coil springs may be weak. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (B.2.1)
55. A vehicle has excessive tire squeal while cornering. The cause of this problem could be:
- a bent steering arm.
  - excessive negative caster.
  - worn stabilizer bushings.
  - worn-out front struts. (B.1.6)

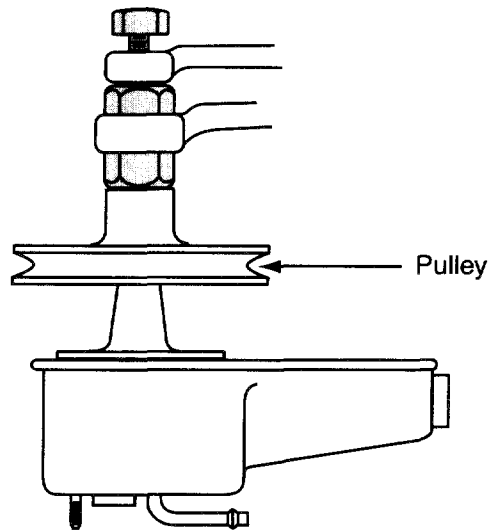


56. In the preliminary procedure, the sector lash adjuster is rotated counterclockwise until it stops, and then rotated clockwise one turn. A turning torque reading is then taken, as shown, with the steering gear in the center position. Following this procedure, the sector lash adjuster should be rotated:
- clockwise until the turning torque is 4 to 10 in. lbs. (0.52 to 1.3 Nm) more than in the preliminary procedure.
  - counterclockwise until the torque is 0 in. lbs. (0 Nm).
  - clockwise until the turning torque is 20 in. lbs. (2.6 Nm) more than in the preliminary procedure.
  - clockwise until the turning torque is 5 ft. lbs. (0.65 Nm) more than in the preliminary procedure. (A.1.6)

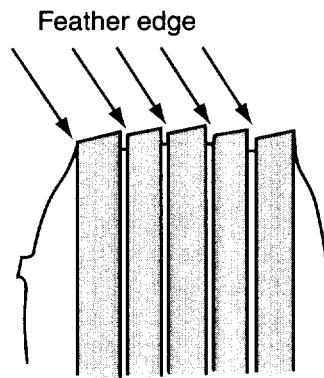
57. Excessive steering effort on a manual steering gear (non-rack-and-pinion type) may be caused by:
- A. a loose worm bearing preload adjustment.
  - B. an overfilled steering gear.
  - C. less-than-specified positive caster.
  - D. a tight sector lash adjustment. (A.1.2)
58. A vehicle has rear chassis waddle. Technician A says this problem may be caused by a steel belt in a rear tire that is not straight. Technician B says this problem may be caused by a bent rear wheel. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.5)
59. All of the following statements about front wheel toe adjustment are true EXCEPT:
- A. The front wheels must be in the straight-ahead position when measuring front wheel toe.
  - B. The front wheel toe should be adjusted before the caster angle on the front suspension.
  - C. After the toe adjustment, the steering wheel must be centered with the front wheels straight ahead.
  - D. While adjusting front wheel toe, a tie rod sleeve rotating tool is used to turn the tie rod sleeves. (C.7)



60. While using a spring compressor to remove a coil spring from a strut, as shown, Technician A says the spring should be taped in the areas where the compressor contacts the spring. Technician B says all of the spring tension must be removed from the upper strut mount before loosening the strut rod nut. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.1.7)
61. Many vehicle manufacturers recommend checking the power steering fluid level with the fluid temperature at:
- A. 60° F (15.6° C).
  - B. 100° F (37.8° C).
  - C. 140° F (60° C).
  - D. 175° F (79.4° C). (A.2.3)



62. The tool shown in the figure is used to:
- remove a pressed-on power steering pump pulley.
  - remove a bolt-on power steering pump pulley.
  - install a pressed-on power steering pump pulley.
  - remove the power steering pump pulley retaining nut. (A.2.8)
63. When one side of the front or rear bumper is pushed downward with considerable weight and then released, the bumper makes two free upward bounces before the vertical chassis movement stops. This action indicates a:
- defective shock absorber.
  - weak coil spring.
  - broken spring insulator.
  - worn stabilizer bushing. (B.3.1)
64. The turning radius on the right front wheel is not within specifications. The cause of this problem could be a:
- worn lower right ball joint.
  - loose outer right tie rod end.
  - worn lower control arm bushing.
  - worn right stabilizer bushing. (C.9)
65. All of the following problems may cause a rattling noise in the rear suspension EXCEPT a:
- broken coil spring.
  - broken coil spring insulator.
  - bent rear strut.
  - worn track bar bushing. (B.2.1)



66. The tire tread shown could be caused by:
- A. excessive positive camber.
  - B. excessive positive caster.
  - C. excessive setback.
  - D. improper toe adjustment. (D.1)
67. A customer complains about steering pull to the left. Technician A says the two front tires may have different tread designs. Technician B says one of the front tires may have a conicity problem. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.6)
68. A customer complains about increased steering effort and rapid steering wheel return after turning a corner. Technician A says both front wheels may have a negative camber setting. Technician B says the rear suspension curb riding height may be reduced. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.2)
69. Dynamic wheel imbalance on a front wheel may cause all of the following problems EXCEPT:
- A. slow steering wheel return to center after turning.
  - B. cupped tire tread wear around the tire tread.
  - C. front wheel shimmy while driving at higher speeds.
  - D. excessive wear on steering linkage components. (D.8)





# 6

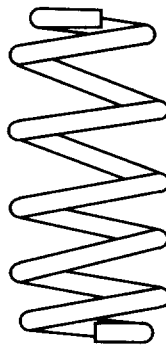
## Additional Test Questions for Practice

### Additional Test Questions

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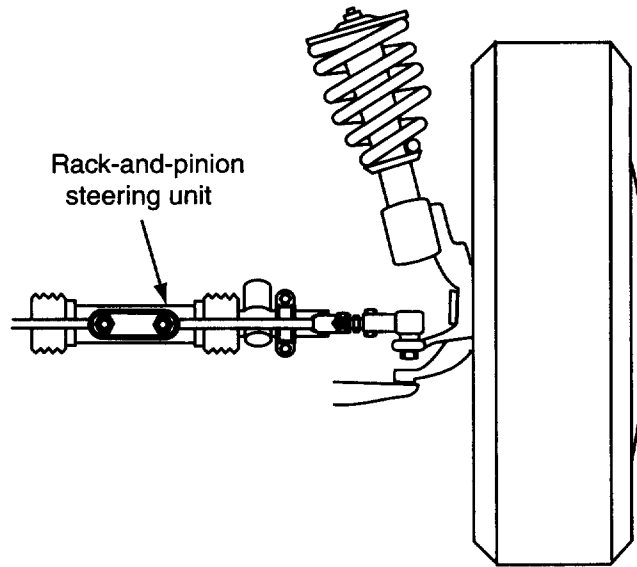
*Please note the letter and number in parentheses following each question. They match the overview in section 4 that discusses the relevant subject matter. You may want to refer to the overview using this cross-referencing key to help with questions posing problems for you.*

1. Many vehicles have an electrically operated device that can vary the firmness of the steering depending on speed and operating conditions. Technician A says the system is designed to make the steering firmer during parking for better control. Technician B says the system is designed to make the steering firmer during high speeds. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B(A.2.18)



2. When installing variable-rate coil springs on a rear suspension, all of the following should be done EXCEPT:
  - A. Spring insulators should be placed on the top and bottom of the springs.
  - B. The closed coils (coils closest together) should be at the bottom.
  - C. Closed coils (coils closest together) should be at the top.
  - D. Springs should be placed so that the end of the spring coils rest in the upper and lower mounts about one-half inch from their stops.(B.2.2)
3. Technician A says power rack-and-pinion gear assemblies do not have to be adjusted. Technician B says manual rack-and-pinion gear assemblies must be adjusted. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B(A.1.8)

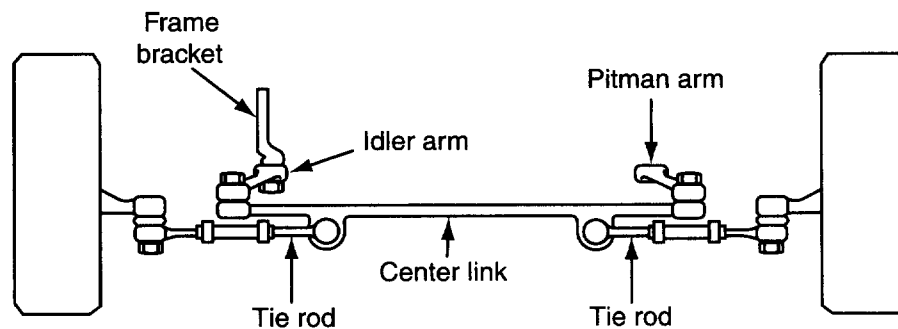
4. On some suspension systems, camber adjustment can be made by doing any of the following EXCEPT:
- A. The upper strut mount holes may be elongated.
  - B. The lower control arm may be heated and bent.
  - C. Cams may be installed at the strut-to-knuckle mount.
  - D. Upper ball joint eccentric spacers may be installed. (C.3)
5. There is a binding problem when turning the steering wheel on a vehicle with rack-and-pinion steering, even with the tie rods disconnected. Technician A says repairs could have been made on the vehicle that required the subframe to be removed and that it was not aligned properly during installation. Technician B says air conditioning repairs, requiring removal of the dash, could have been made and the steering column mount not neutralized. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.1)
6. There is a dull noise and a feeling that something shifted when making a hard turn on a car with rack-and-pinion steering. Technician A says the rack mounting bushings could be dried out and loose. Technician B says the rack mounting bushings could be oil soaked. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.12)
7. Technician A says wheel and tire runout can only be corrected by parts replacement. Technician B says because front-wheel-drive cars are smaller and lighter than rear-wheel-drive cars, wheel and tire runout are not as critical and do not cause many problems. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.5)



8. An inspection is being performed on the rack-and-pinion steering system shown in the figure. All of the following should be checked EXCEPT the:
- A. ball joints.
  - B. tires.
  - C. Pitman arm.
  - D. tie rods.
- (A.1.3)
9. A vehicle's ride height is too low. All of the following could be the cause EXCEPT:
- A. defective shock absorbers.
  - B. a broken coil spring.
  - C. a misadjusted torsion bar.
  - D. a weak or sagging leaf spring.
- (B.1.1)
10. A vehicle with rack-and-pinion steering was recently aligned; the customer came back complaining that the vehicle sometimes darts toward the side of the road after hitting a bump. Technician A says the caster may be too close to zero degrees. Technician B says the rack mounting bushings may be worn and loose. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.10)
11. Some idler arms are adjustable. Technician A says the adjustment enables settings to allow the vehicle to turn in a tighter circle. Technician B says the adjustment is to give the driver more road feel. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.4)

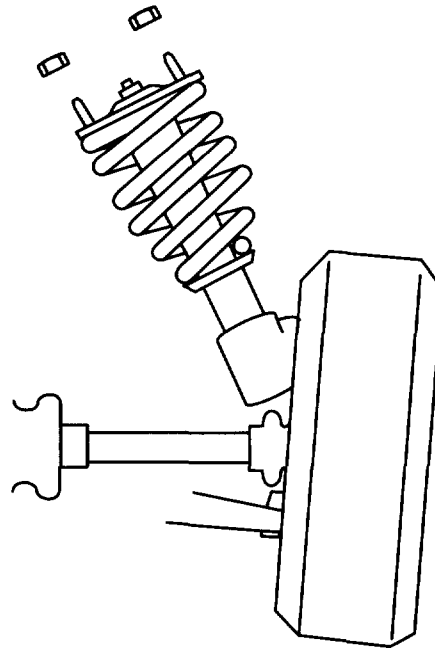
12. At specified intervals and during major repairs to the system, the power steering system should be flushed and refilled. The fluid type recommended by the manufacturer must be used. Technician A says to mount the pump on the vehicle with the return port plugged, fill the pump and, with the front wheels off the ground and the return hose in a drain pan, start the engine and slowly turn the steering wheel from stop to stop. This would be done with about two quarts of fluid to flush the system and bleed air out of the system. Technician B says to use the same procedure, but use cleaning solvent for the flush to dissolve the gum and varnish. Then, fill the system to the proper level with the proper fluid. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.17)
13. A vehicle with non-independent rear suspension has been aligned and has been test driven several times. The technician notices on the test drive that the steering wheel is cocked to the right. Front toe is readjusted and the vehicle is driven again. The technician notices that the steering wheel is still cocked to the right. Technician A says the rear axle assembly may be misaligned, causing the thrust angle to be off center. Technician B says that one or both of the rear wheels' toe settings could be incorrect causing thrust angle to be off center. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.13)
14. While discussing the common service items on leaf springs, Technician A says the spring eye bushings may wear and can be replaced. Technician B says the interleaf separators can wear or move and may need replacement. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.2.1)
15. On some vehicles, caster may be adjusted by doing any of the following EXCEPT:
- A. adding shims to one or both sides of the control arm.
  - B. lengthening or shortening the strut rod.
  - C. tightening the torsion bar adjusting bolt.
  - D. turning eccentric cams located on the control arm.
- (C.5)
16. When replacing a power steering pump belt, the best way to assure proper belt tension is to:
- A. check by hand for 1 inch deflection.
  - B. tighten to the specification written on the belt.
  - C. use a belt tension gauge.
  - D. use a large pry bar to get the belt as tight as possible.
- (A.2.4)
17. Technician A says tire rotation equalizes wear among the four or five tires rotated. Technician B says different vehicle manufacturers may recommend different rotation patterns. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (D.4)

18. During a routine steering inspection on a rack-and-pinion system, the technician finds that a bellows boot is cracked. The technician should:
- use a good quality silicone sealer to fill the crack.
  - ignore it; this is a normal condition.
  - replace the bellows boot.
  - inspect and/or replace the inner tie rod, and replace the bellows boot. (A.1.9)
19. The steering axis inclination or kingpin inclination (SAI/KPI) was checked on the vehicle and the included angle determined is three degrees less on the left side than the right side. Technician A says that if the caster and camber settings are in specifications, the handling and tire life will be acceptable. Technician B says that SAI differences of over three degrees can cause steering pull when accelerating or braking. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (C.10, B.1.5)
20. Technician A says that as long as the steering wheel spokes are straight, the steering wheel is in a center position. Technician B says that to center a steering wheel you must first turn the wheel from stop to stop counting the number of turns, then turn the wheel back half that amount to obtain a center position. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (C.8)
21. During removal and installation of a recirculating-ball manual steering gear, all of the following should be checked for wear EXCEPT:
- the sector shaft.
  - the gear housing.
  - the rack-piston preload.
  - the Pitman arm. (C.2)



22. In the figure shown, front wheel toe is found to be incorrect. The problem could be all of the following EXCEPT:
- misadjusted tie rods.
  - an incorrectly adjusted steering gear.
  - a bent center link.
  - a bent Pitman arm. (B.2.7)

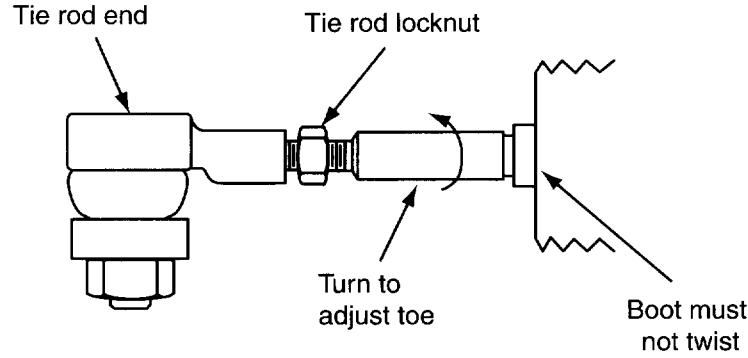
23. A vehicle with front leaf springs has a rattle in the front suspension when going over bumps. Which of the following is the most likely cause?
- A. A broken leaf spring
  - B. A missing insulator (silencer)
  - C. A worn shackle
  - D. A broken center bolt (B.1.1, B.1.8)
24. Technician A says MacPherson strut assemblies are often changed because the vehicle bounces too much on irregular roads. Technician B says that when a new MacPherson strut cartridge is installed, the oil is left in the old housing when the new cartridge is installed to help heat transfer from the cartridge to the housing. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.1.11)
25. Bent steering arms or steering knuckles/spindles are almost always caused by accidents involving the vehicle. Technician A says a thorough visual inspection will find some bent steering arms or bent steering knuckles/spindles, but technicians must use the alignment equipment checking toe-out on turns and steering axis inclination for more information about the condition of the named parts. Technician B says if the caster, camber, and toe settings are within specifications, the parts named do not have to be replaced. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.1.6)
26. While inspecting the front and rear steering linkage geometry, including parallelism, vehicle ride height is being discussed. Technician A says wrong vehicle ride height can cause tires to wear even though the vehicle has had the caster, camber, and toe set to specifications. Technician B says that wrong ride height can cause vibrations to come from the drive train on a front-wheel-drive vehicle. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.1)
27. Technician A says that some steering shaft assemblies use a flexible coupling. Technician B says that worn steering shaft U-joints can cause steering wheel play. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.1)
28. A vehicle has excessive wear on the outside of the left rear tire. Technician A says the first step is to put the vehicle on a hoist and check for loose, worn, bent, warped, and misaligned parts. Technician B says that after a good inspection, carry out a further diagnosis using four-wheel alignment equipment. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.1)



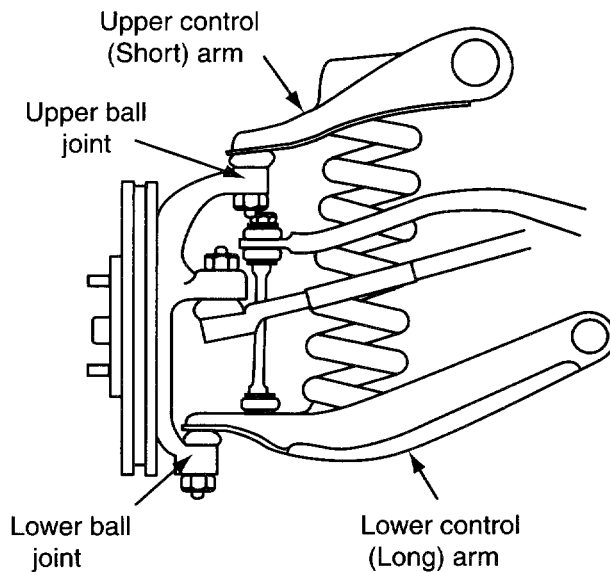
29. When replacing a rear shock absorber, as shown, which should be done first?
  - A. Lift the vehicle on a hoist and support the rear axle.
  - B. Remove the shock absorber.
  - C. Disconnect the upper shock mounting nut and grommet.
  - D. Remove the lower shock mounting nut or bolts. (B.3.1)
  
30. A vehicle has continued tire wear problems and has had two blowouts even after several alignments. Technician A says the vehicle tire information label should be checked to determine if the right tires were installed on the vehicle. Technician B says that the recommended tires, or a better grade than recommended, must be used for legal and safety reasons. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.1)
  
31. A customer is complaining about a leak in the air shock system. Technician A says to put 50 psi (345 kPa) air pressure in the system and check for leaks with a soap solution. Technician B says to put 100 psi (690 kPa) air pressure in the system and let the vehicle stand overnight. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.3.2)
  
32. To replace the inner tie rod on a rack-and-pinion steering gear the technician should first:
  - A. remove the bellows boot.
  - B. place the special tool on the inner tie rod shaft.
  - C. remove the outer tie rod end.
  - D. remove the wheel and tire assembly. (A.3.5)

33. When replacing the power steering pump O-ring seals, which of the following should the technician use to lubricate them?
- A. Power steering fluid only
  - B. A good quality water-based lubricant
  - C. Petroleum jelly
  - D. Chassis grease (A.2.7)
34. A vehicle has an air suspension system and the customer complains that the vehicle leaks down a little overnight and takes a long time to refill the air bags to the proper level. Technician A says when the temperature drops at night, the air is cooler and the vehicle height would drop a little. Technician B says it is not abnormal for the vehicle to lower a little overnight, but if the pump is good, the system should refill within two minutes of startup. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.3.4)
35. During the alignment process, proper camber specification cannot be achieved on one of the wheels. Technician A says that the steering axis inclination (SAI) should be checked because a bent spindle could be the cause. Technician B says that the adjustment holes should be elongated to allow for added camber movement. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.1.6)
36. Shock absorbers are being inspected on a vehicle. Technician A says that a light oil film on the housing of the shock absorber indicates the shock is faulty. Technician B says that oil on the outside of the shock does not matter as long as it passes a bounce test. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.3.1)
37. Technician A says thrust angle is an imaginary line that is at a 90-degree angle to the centerline of the rear wheels. Technician B says the geometric centerline is adjustable. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.13)
38. Technician A says that steering axis inclination (SAI) may need correction if proper camber specifications cannot be achieved during an alignment. Technician B says that correcting SAI requires replacing parts such as the spindle or strut assemblies. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.10)





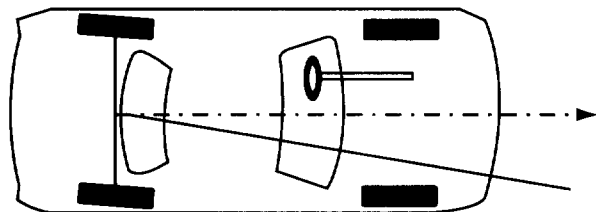
39. After adjusting toe by rotating the inner tie rod on a rack-and-pinion system, the technician should:
  - A. tighten the outer tie rod locknuts.
  - B. readjust the steering gear.
  - C. center the steering wheel and lock it in place.
  - D. tighten the idler arm. (A.3.5)
  
40. During an alignment check of a vehicle with air suspension at all four wheels, the right front height measurement is found to be 0.625 inch (15.9 mm) higher than the left front. Technician A says the height sensor may be disconnected. Technician B says the height sensor adjustment could have slipped. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.3.4)
  
41. Power steering hoses must be replaced if:
  - A. fluid is showing at the threaded fitting.
  - B. fluid is showing at the molded steel fitting near the end of the hose.
  - C. the hose is contacting the body and transmitting noise to the passenger compartment.
  - D. a heavy-duty hose is used on a light-duty application. (A.2.10)
  
42. Technician A says all steering wheels can be centered once the toe settings are correct by moving both adjustments in the same direction. Technician B says it is easier to center the steering wheels by pulling the steering wheel off of the shaft and moving it until it is centered. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.8)
  
43. Technician A says that some vehicles may require a tie rod adjustment or shims to be added to adjust rear toe. Technician B says that not all vehicles have a rear toe adjustment and that parts may need to be replaced if toe is found to be incorrect. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.12)



44. When removing a lower control arm on a short arm/long arm suspension system, as shown, the technician should:
- compress the spring to remove all spring load from the control arm.
  - disconnect the ball joint first.
  - lubricate the control arm bushing with transmission oil for easy removal.
  - support the weight of the vehicle by the lower control arm to unload the ball joint for easy removal. (B.1.2)
45. A customer complains of tire wear on the outside tread of the right front tire and the left rear tire. The suspension has no provisions for camber adjustment, front or rear. Technician A says to call the local parts house to see if any special shims are available to enable camber changes. Technician B says to check information sources (including hotlines) to find out if any adjustment kits or special procedures were suggested for this vehicle. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (C.4)
46. A vehicle with nonadjustable caster (no aftermarket kits available) has a severe pull to the left while driving. Technician A says to let some air out of the right front tire and do a road test to see if the pull is still there. Technician B says it could be tire lead and to swap the two left side tires and do a road test to see if pulling to the left is still there. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (D.6)
47. Fluid leaks are the main reason that power steering pumps are serviced. Technician A says that front seals leak when there is too much shaft play. Technician B says the front seals and gaskets can leak when the wrong fluid is put in the power steering system. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (A.2.5)

48. Technician A says setback problems can be caused by accident damage to the front cradle. Technician B says most front cradles have a suggested alignment or centering procedure upon installation to ensure that the proper geometric centerline is maintained. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.3.5, C.15)
49. The power steering box has been resealed twice and still shows signs of slight weeping. Technician A says the cast iron of the steering box could be porous. Technician B says the O-rings, seals, and gaskets could be defective. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.1)
50. Technician A says to change the steering linkage damper if it shows signs of leaking or if it has dents in the cylinder housing. Technician B says to change the steering linkage damper whenever there is a vibration in the steering at high speeds. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.6)
51. While adjusting the ride height on a car with a torsion bar suspension system, Technician A says to relocate the mounting of the torsion bar. Technician B says to adjust the tension of the torsion bar by preloading it. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.9)
52. When adjusting a torsion bar, the technician should:
- A. remove the torsion bar, heat it, twist it, and reinstall it.
  - B. increase or decrease the tension or twist on the bar.
  - C. add shims to increase the bar tension.
  - D. replace the torsion bar mounting bracket with a bracket that has the specified amount of offset.
- (B.1.9)
53. Two technicians are discussing the proper way to check a ball joint for radial and axial movement. Technician A says if the lower ball joint is the loaded joint, a jack should be placed under the lower control arm to relieve the load from the joint. Technician B says if the upper ball joint is the loaded joint, a spacer should be placed between the upper and lower control arms and the jack placed under the frame. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.4)

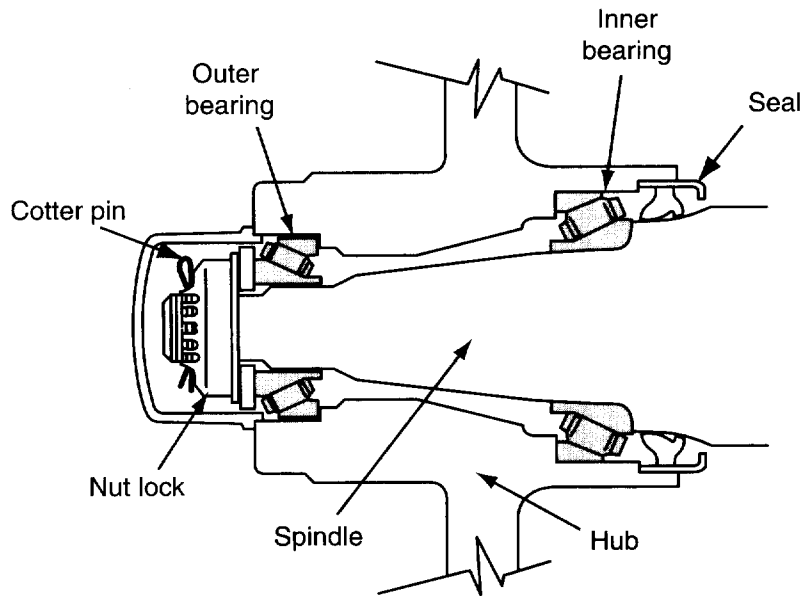
54. When performing an alignment, the technician finds that included angle is not right. Which of the following should the technician do first?
- A. Check ride height.
  - B. Check camber.
  - C. Check thrust angle.
  - D. Replace the rear springs. (C.10)
55. Technician A says worn strut rod bushings can cause brake pull problems. Technician B says worn strut rod bushings can cause alignment problems. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (B.1.3)
56. When removing a rack-and-pinion steering gear, it is necessary to do all of the following EXCEPT:
- A. disconnect the tie rods.
  - B. disconnect the mounting brackets.
  - C. center the steering wheel.
  - D. disconnect the U-joint coupler. (A.1.7)
57. On a vehicle with rack-and-pinion steering, there is a lack of power steering assist when turning to the left. Right-turn assist is normal. Technician A says that the rack piston seal could be defective. Technician B says that the rotary spool valve seals could be defective. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.2)
58. Wheel and tire vibrations cause shimmy, noise, and tire wear problems. Technician A says wheel and tire vibrations can come from heavy spots on either the wheel or the tire. Technician B says the most expensive tires do not have to be balanced. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.3)
59. Technician A says if there is oil in the right-hand boot of a manual rack, both boots need to be changed because the oil can get to both sides through the equalizer tube. Technician B says if the right-hand boot has oil dripping, the rack and pinion should be rebuilt or replaced. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.2)
60. The steering on a rack-and-pinion system binds in the same spot every time the vehicle turns right. Technician A says the problem must be a loose idler arm hitting the frame. Technician B says the problem could be a dent in the rack body. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.3)



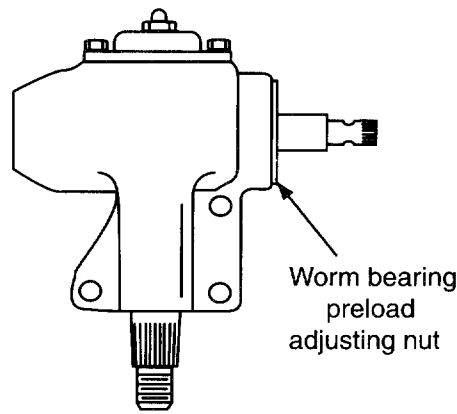
61. During a routine alignment it is found that the thrust angle is incorrect. Which of the following should the technician do first?
- Set front toe to compensate.
  - Check ride height.
  - Rotate the tires side to side.
  - Check to see if the rear wheels have a toe adjustment. (C.13)
62. Two technicians are discussing the servicing of MacPherson struts. Technician A says that some units have replaceable shock inserts. Technician B says that some struts must be replaced as a unit and cannot be serviced. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (B.1.11)
63. Technician A says that excessive steering wheel play can be caused by worn tie rod ball sockets. Technician B says that steering wheel play can be caused by a worn idler arm. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (A.2.1)
64. Technician A says when changing inner tie rod ends, a special socket is available that fits on an impact wrench. This socket is put over the tie rod and then the impact wrench is used to turn the socket. Technician B says when removing inner tie rod ends, the rack must be held securely so that pressure is not applied to the pinion teeth, causing them damage. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (A.3.5)
65. When installing air shocks, all of the following statements are true EXCEPT:
- The lines should be routed away from moving suspension components and exhaust.
  - The fill valve should be mounted in an easily accessible location.
  - The air shock should be filled with maximum air pressure at all times.
  - The air shock should be installed before filling with air. (B.3.2)
66. A variable-assist steering system does not alter the assist with vehicle speed changes. Technician A says the power steering pump could be at fault. Technician B says that the steering wheel rotation sensor could be at fault. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B (A.2.18)

67. All of the following are parts of a typical MacPherson strut suspension EXCEPT a (an):
- A. shock absorber.
  - B. coil spring.
  - C. lower control arm.
  - D. upper control arm. (B.1.11)
68. During a power steering system hydraulic test it is determined that the pressure output is normal but that the flow registers low. Technician A says this is a normal condition for some power steering systems. Technician B says that both pressure and flow must be within specifications for the system to operate correctly. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.9)
69. A power steering pump pulley is bent and needs to be replaced. Technician A says the installation tool automatically stops when the pulley has been pressed on to the right position. Technician B says the pump must be disassembled to replace the pulley. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.8)
70. While performing an alignment on a front-wheel-drive vehicle, the technician notices that caster is out of specification and that caster is not adjustable on the vehicle. Which of the following should the technician do first?
- A. Replace both front strut assemblies.
  - B. Heat and bend the lower control arms.
  - C. Check the cradle (subframe) alignment.
  - D. Measure thrust angle. (B.3.5, C.15)
71. Which of the following is an effective way to check for a bent strut?
- A. Measure the wheelbase and compare the readings side to side.
  - B. Use a straightedge against the strut spring assembly.
  - C. Visually check the angle of the strut in its mounts.
  - D. Compare the loaded and unloaded camber readings of the two front wheels. (B.1.11)
72. A vehicle has an excessive amount of tire wear on the outside tread of the right front tire. Technician A says the right front wheel has excessive negative caster. Technician B says that the vehicle has an excessive amount of toe-out. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.1)

73. During a test drive, the technician notices that the vehicle veers rapidly when encountering bumps in the road. Technician A says that the rack-and-pinion mounting bushings could be defective. Technician B says that the rack-and-pinion mounting bracket could be bent. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.10)



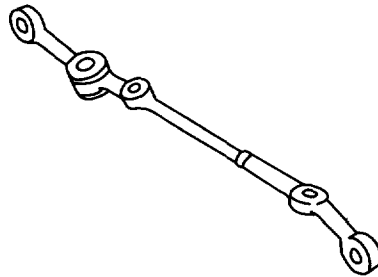
74. Two technicians are discussing the proper way to replace the tapered roller bearing set shown in the figure. Technician A says the specifications for tightening these types of bearings usually leave sufficient free play to allow for heat expansion. Technician B says that slight free play is not necessary and the spindle nut should be tightened by hand as much as possible. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.3.3)
75. Which is the right order for setting rear toe adjustments?
- A. Caster, camber, toe
  - B. Camber, caster, toe
  - C. Thrust line, toe, camber
  - D. Camber, thrust line, toe
- (C.12)



76. When adjusting worm bearing preload on a non-rack-and-pinion power steering gear, as shown, Technician A says some steering gears require a rotational torque specification to be met. Technician B says that some steering gears require the technician to drain the fluid before performing this adjustment. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.2.15)
77. What could cause air bubbles in the power steering fluid?
- Checking the fluid before it reached operating temperature
  - Overheated fluid
  - Engine idling too fast
  - Slightly low fluid level
- (A.2.3)
78. A power steering system analyzer was installed for diagnosis on a vehicle with a hard steering problem. Technician A says if there are 4 to 5 gallons (15 to 19 liters) of flow at 2,000 rpm, the pump mechanism and flow control valve are OK. Technician B says if the pressure is near 1,200 psi (8,274 kPa) at 2,000 rpm, then the pressure relief valve is OK. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.2.9)
79. After bleeding a power steering system, aeration (foaming) is still found in the power steering fluid. The technician should:
- repeat the procedure.
  - drain the system and refill with power steering fluid.
  - change the flow control valve in the power steering pump.
  - add approved antifoaming agents to the power steering fluid.
- (A.2.17)
80. Specification for toe on a vehicle calls for  $\frac{1}{8}$  inch toe-in. Technician A says that while using an alignment machine, each wheel should be adjusted to  $\frac{1}{16}$  inch toe-in. Technician B says that  $\frac{1}{8}$  inch toe-in should be set on each wheel. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (C.7)

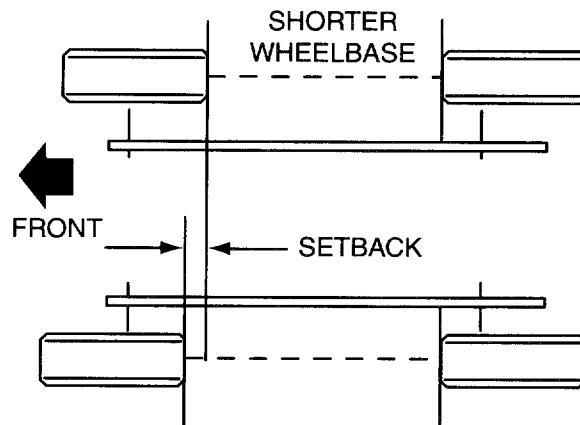


81. The LEAST likely cause of a bent power steering pump pulley is:
- A. normal wear.
  - B. the vehicle was in a collision.
  - C. the pulley was used as a pry rest.
  - D. the pump was dropped during normal service. (A.2.8)
82. A vehicle has a serpentine belt and the power steering pump pulley is out of alignment. Technician A says that on many cars, the pulley can be moved into alignment without removing the pump if the right special tool is used. Technician B says the best way to align the pulleys is to loosen the pump and use shims between the pump bracket and the head/block. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.4)
83. The left-hand rear strut has been replaced on a vehicle. The technician should:
- A. bounce the rear of the vehicle to seat the spring.
  - B. perform a four-wheel alignment starting with the rear wheels.
  - C. tack weld the strut assembly to the steering knuckle so that there is no movement.
  - D. paint the piston rod on the strut assembly so that it will not rust. (B.2.5)



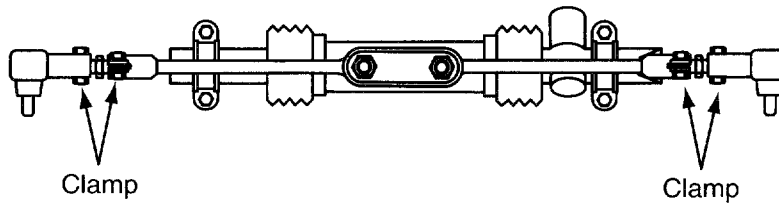
84. The center link shown attaches to the Pitman arm and the idler arm. Technician A says if the center link has a ball-and-socket joint at one end that is loose, the whole center link must be replaced. Technician B says if one of the tapered holes is distorted, the whole center link must be replaced. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.3.3)
85. Technicians are discussing the removal and replacement of a non-rack-and-pinion power steering gear on a vehicle with air bags. Technician A says when removing the steering box from a vehicle with an air bag, a remote power supply should be connected to the cigarette lighter socket before disconnecting the battery to prevent accidental deployment of the air bag. Technician B says that there is no need to drain the fluid from the power steering pump. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.11)

86. A vehicle has a noticeable vibration at 60–65 mph. The vibration is felt through the steering wheel and occurs in all gear ranges. Which of the following should the technician do?
- Align the front wheels.
  - Check shock absorber operation.
  - Balance the wheels.
  - Balance the drive shaft.
- (D.8)
87. Technician A says if an electronically controlled 4WS system enters fail-safe mode, voltage will be shut off to the rear steering unit and it will move to its center position. Technician B says that in fail-safe mode, the control unit will illuminate a warning light on the instrument panel. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.2.18)



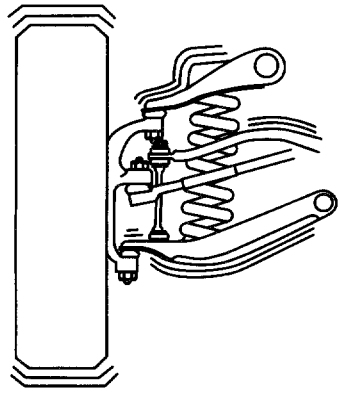
88. Technician A says that incorrect side-to-side wheelbase readings could indicate a front wheel setback problem. Technician B says that some front wheel setback is allowable. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (C.14)
89. When checking and filling a power steering system, all of the following statements are true EXCEPT:
- Only a manufacturer-approved fluid should be used.
  - Fluid level can be checked when hot or cold.
  - When filling a drained system, the steering wheel should be turned from stop to stop.
  - Any good quality motor oil or transmission oil can be used.
- (A.2.3)

90. While aligning the front wheels of a vehicle, the technician reads the specification for camber as one-degree positive camber plus-or-minus two degrees. Technician A says that the operating range for camber on this vehicle is from negative one degree to positive three degrees camber. Technician B says that camber may be adjusted anywhere within this range as long as it is equal from side to side. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.3)
91. A vehicle with power steering has increased steering effort in both directions. Technician A says that a bent center link could cause this problem. Technician B says that a seized idler arm could cause this problem. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.4)
92. The power steering box has had two new seal kits installed in the last 5,000 miles (8,045 kilometers) and again has a leak. Technician A says the sector shaft bearing or bushing may be worn. Technician B says the sector shaft cover may be cracked or worn. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.1)
93. When replacing a power rack-and-pinion steering gear, all of the following should be done EXCEPT:
- A. The pump and lines should be flushed.
  - B. Adjustments to the gear should be done before installation.
  - C. The rack should be centered in its travel.
  - D. The outer tie rod ends should be connected to the steering arms first.
- (A.2.12)
94. While aligning a vehicle with nonadjustable caster, the technician finds that caster is two degrees less positive on the left wheel and the vehicle is pulling left. Technician A says that the control arms and control arm bushings should be inspected for faults. Technician B says that the tire wear pattern should be inspected for excessive caster wear. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.6)

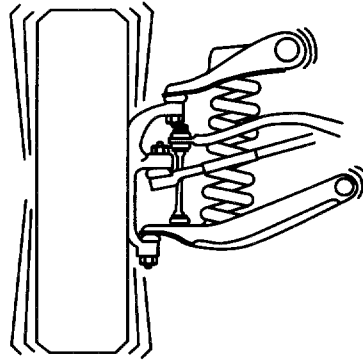


95. Technician A says tie rod adjusting sleeve clamps, like the ones indicated in the figure, must be positioned a certain way on the sleeve or the sleeve may not grip the threaded end of the tie rod properly, resulting in loss of steering control. Technician B says on certain vehicles, the tie rod adjusting sleeve clamps must be properly positioned as shown to prevent interference problems with other suspension parts. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.3.5)
96. Upon inspection, a steering linkage damper is found to have a light coating of oil near the point at which the piston rod protrudes from the housing. Technician A says that the steering damper is leaking and should be replaced. Technician B says that the steering damper should be resealed. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (A.3.6)
97. Stabilizer bars are used on both the front and the rear suspension of many vehicles. Technician A says if inspection reveals the suspension height to be too low on one corner, the stabilizer bar could be the cause. Technician B says if the rear of a vehicle bounces too much while driving, the stabilizer bar could be the cause. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (B.1.10)
98. Two technicians are discussing the right procedure for removing a coil spring. Technician A says that before the control arm is disconnected from the steering knuckle, the spring should be compressed with the proper compressor. Technician B says that the shock absorber should be removed before removing the spring. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (B.1.7)

99. Load-carrying ball joints are usually serviceable with up to 0.060 inch (1.52 mm) of free play. Non-load-carrying ball joints are not allowed any free play. Technician A says to place safety stands under the frame just to the rear of the front wheels to check for loose lower ball joints on a large rear-drive vehicle. Technician B says to place the safety stands under the lower arms, near the ball joints of front-wheel-drive cars, when checking for play in the lower ball joints. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.4)
100. Front wheel bearings are being serviced on a rear-wheel-drive vehicle, and there are metal flakes near the bearing rollers of the outer bearing only. Technician A says the outer bearing and race must be replaced and the other bearings should be cleaned, inspected, and packed with the proper grease. Technician B says all of the bearings on the front wheels should be replaced if one is bad because they have had the same amount of wear. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.3.3)
101. The customer complains that after taking a sharp corner at slow speeds, the vehicle pulls in that direction, either right or left. What could be the cause?
- A. Steering box
  - B. Torque steer
  - C. Bump steer
  - D. Memory steer
- (C.1)
102. Technician A says the upper strut bearing and support plate are often the sources of noise complaints. The noises can occur while turning or while going over irregularities in the roadway. Technician B says the caster/camber adjuster plates at the top of the struts cause much of the front suspension noise complaints while driving. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.12)
103. When the prealignment checks are completed, Technician A says rear camber should be adjusted to specification first and then the rear toe should be set to specification, making sure the thrust line setting is at zero when the rear toe settings are complete. Then the front caster, camber, and toe adjustments are made in that order. Technician B says because the front alignment settings are more important to tire wear, the caster, camber, and toe adjustments on the front wheels should be done before doing the rear wheel adjustments. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.3.1)



Radial runout

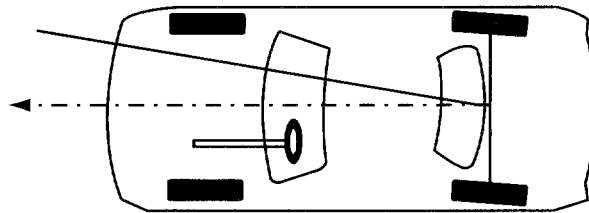


Lateral runout

104. Technician A says that excessive tire radial runout could cause wheel tramp (wheel hop). Technician B says that excessive tire lateral runout could cause wheel shimmy. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (D.5)
105. A vehicle's tires have a wear pattern that would indicate the toe needs to be adjusted. Upon checking the alignment, the caster, camber, and toe settings are found to be correct but the vehicle's turning radius (toe-out on turns) is found to be zero degrees different and should be one and one-half degrees different. What could be the cause?
- Overloaded vehicle
  - Hard cornering
  - Bent spindle
  - Bent center link
- (D.1, B.1.6)
106. Technician A says included angle is not adjustable and cannot be a problem if it is wrong, so it is of no concern during alignment. Technician B says that if the included angle is more than one and one-half degrees different from the right to left side, the vehicle could pull slightly to one side during accelerating or braking. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (C.11)
107. Technician A says some vehicles call for more air pressure in the rear tires than in the front tires, and the information given on the decal should be followed. Technician B says sometimes it is acceptable to put more air in the tires on one side of the vehicle than in the tires on the other side to adjust for road crown. Who is right?
- A only
  - B only
  - Both A and B
  - Neither A nor B
- (D.2)

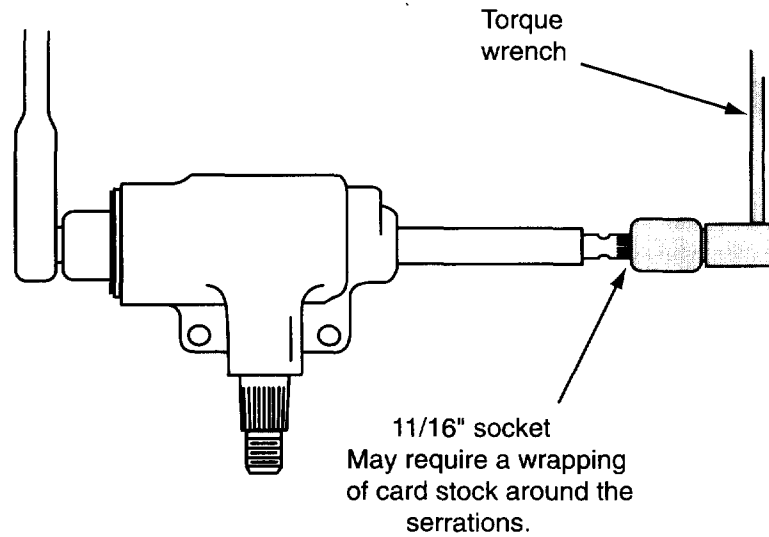
108. Technician A says that when adjusting a manual steering gear (non-rack and pinion), sector lash should be set first. Technician B says that worm bearing preload should be adjusted last. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.6)
109. A vehicle with power steering pulls to the right. Technician A says that this could be caused by an internal leak in the steering control valve. Technician B says that incorrect wheel alignment could be the cause. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (C.1)
110. When removing a non-rack-and-pinion steering gear on a car with air bags, Technician A says that while the steering shaft is disconnected, the steering wheel must remain centered. Technician B says that while the steering shaft is disconnected, the air bag clockspring connector should be removed. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.1.4)
111. A power steering system has a lack of power steering assist, or hard steering, in both directions. It is determined through testing that the fault is within the non-rack-and-pinion steering gear. The most likely cause of the fault is:
- A. a bypassing rotary spool valve.
  - B. overadjusted sector lash.
  - C. a bypassing power piston seal.
  - D. worm bearing preload that is too loose. (A.2.1)
112. When replacing the power steering pump, Technician A says that a pump with the same flow-control specifications should be used. Technician B says that on some pumps the flow-control mechanism can be adjusted to fit the application. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (A.2.6)
113. Technician A says the most accurate way to balance a wheel and tire assembly is on a spin balancer in dynamic mode. Technician B says that another way to balance a wheel and tire assembly is on a bubble type balancer in dynamic mode. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B (D.8)

114. Rear leaf springs rarely need to be serviced, but they sometimes sag or break. Technician A says sometimes the center bolt breaks, causing dog tracking and tire wear. Technician B says sometimes the bushings and insulator pads deteriorate, causing a noise complaint. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (B.2.4)
115. Technician A says that when adjusting a manual steering gear (non-rack and pinion), worm bearing preload should be adjusted last. Technician B says that the sector lash adjustment should be made with the ball nut at the end of its travel. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (A.1.6)
116. Technician A says that when setting caster and camber to specifications, too much setback will not cause a problem. Technician B says all vehicles have some setback on the right side. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (C.14)



117. When performing an alignment, thrust angle is found to be out of specification. The LEAST likely cause is:
- A. defective rear control arm bushings.  
 B. a bent rear control arm mount.  
 C. defective rear sway bar bushings.  
 D. a bent rear control arm. (C.13)

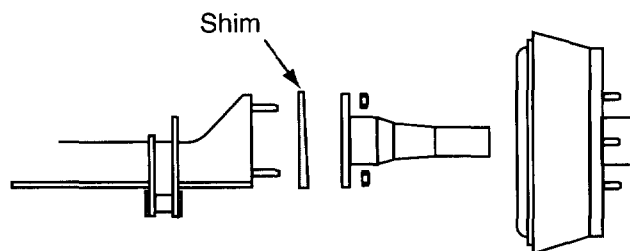




118. Technician A says that when adjusting a power-assisted steering box, using the method and tools shown, the worm bearing adjuster nut is tightened to 45 ft. lbs. (61 Nm) to make sure there is no lash at the worm bearings. Technician B says to apply a 20 ft. lbs. (27 Nm) torque on the worm shaft adjuster plug and then back off the adjuster plug until there is about 0.006 inch (0.152 mm) lash. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.12)
119. A vehicle that has been aligned still pulls to the left. Which of the following should the technician do first?
- A. Switch the front tires from side to side to determine if the pull switches direction.
  - B. Realign the vehicle.
  - C. Put maximum recommended air pressure in all the tires.
  - D. Retighten all of the wheel nuts to diminish wheel-to-hub runout.
- (D.6)
120. Upon road testing a front-wheel-drive vehicle, the technician finds that the vehicle must be countersteered in the opposite direction after every turn. Technician A says that this could be caused by a seized upper strut bearing. Technician B says that this condition is known as memory steer. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (C.1, B.1.12)
121. The vehicle makes loud snapping noises when turning right and seems to turn a tighter radius in one direction. Technician A says the steering box mount to the frame or chassis could be cracked. Technician B says the steering column could be bent and hitting the outer housing. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.1.2)

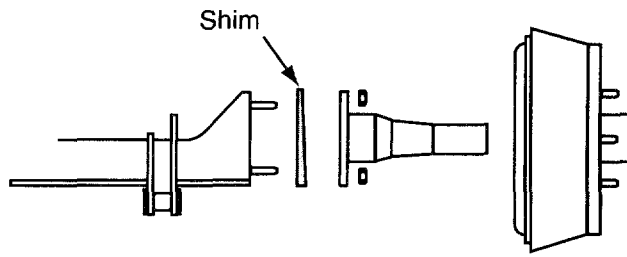
122. The customer complains about a loose feeling in the steering of his low mileage, front-wheel-drive vehicle with rack-and-pinion steering. None of the suspension or steering parts are worn. Technician A says try to adjust the pinion shaft bearing preload and the rack guide to remove the looseness. Technician B says it is necessary to remove the rack for a close inspection. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (A.2.15)
123. A high-mileage vehicle shows wear on the front tires. The wear appears to have been caused by wrong toe settings; but when the alignment is rechecked, all of the measurements are within specifications. Technician A says nothing more can be done without replacing all of the front suspension parts, because of the aging and natural deterioration of the vehicle. Technician B asks the customer how the vehicle is loaded during use and makes new toe adjustments with an assistant, whose weight is close to the driver's weight, sitting in the front seat and the usual load in the vehicle. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (D.1)
124. While inspecting ball joints and tie rod ends, Technician A says rear ball joints are checked much like front ball joints: determine the load-carrying ball joint, support the vehicle properly, and check for play. Technician B says rear tie rod ends are checked much like front tie rod ends and must not have any free play from side to side. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.2.7)
125. All of the following statements are true of sway bars EXCEPT:
- A. The bars are also called stabilizer bars.
  - B. If both wheels jounce, the bar pivots in its mounts.
  - C. The bar connects the lower control arms to the frame.
  - D. The bar transfers the movement of the suspension of one wheel to the suspension of the other wheel.
- (B.2.3)
126. A vehicle has a droning vibration noise only when driven at high speeds with two people in the back seat. Technician A says it could be a sway bar that's not seated properly. Technician B says the coil springs could be wrong (load rating too high). Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.2.1)

127. When rotating tires, Technician A says that directional tires should be on the side of the vehicle on which they were originally installed. Technician B says directional wheels installed on the wrong side of the vehicle could cause the brakes to overheat. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (D.4)
128. While diagnosing a squeak in a suspension system it is determined that one of the sway bar-to-frame bushings is making a noise. Technician A says that the sway bar bushing could be replaced to correct the problem. Technician B says that a good quality silicone lubricant could be used on the bushing. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (B.10)
129. While discussing transversely mounted torsion bar front suspension and longitudinal torsion bar front suspension, Technician A says that if one of the two torsion bars on either type system breaks, the new one ordered fits either side. Technician B says when doing an alignment on a vehicle with either type of torsion bar suspension, the torsion bars are adjusted last. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (B.1.9)
130. A vehicle pulls right or left even though all of the alignment adjustments are correct and there is no frame or body damage. Technician A says the tire could have conicity. Technician B says one of the tire and wheel assemblies must be severely out of round. Who is right?
- A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (D.6)



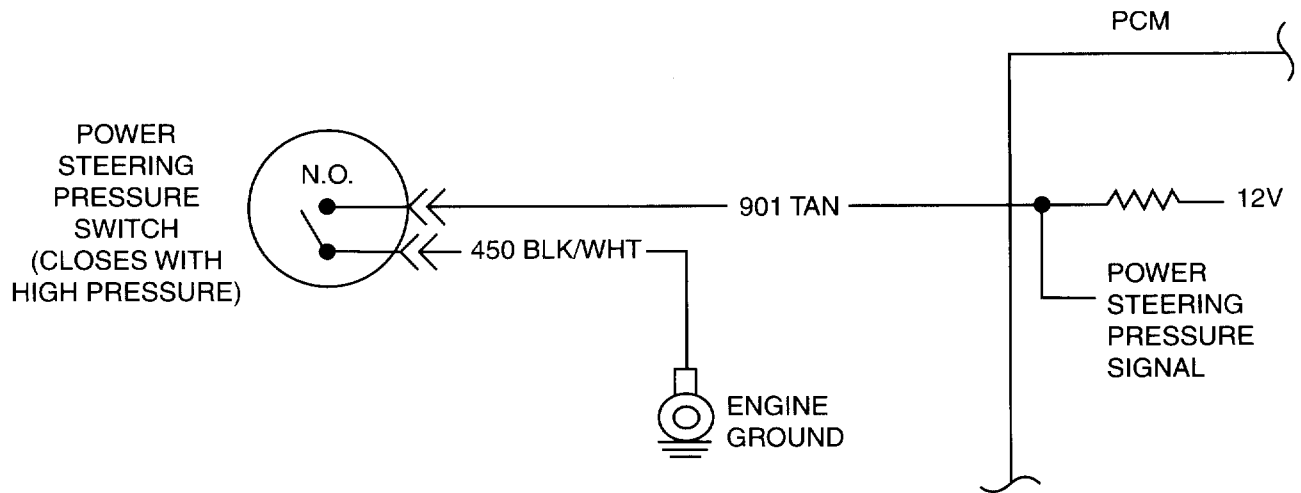
131. In the figure, the shim installed between the rear spindle and housing is for:
- A. caster adjustment.  
 B. turning radius correction.  
 C. antilock brake (abs) sensor adjustment.  
 D. toe adjustment. (B.2.8)

132. When replacing directional tires on mating directional wheels, Technician A says the wheel and tire must be mounted to match directional rotation. Technician B says the tire and wheel assembly must be installed on either the left or right side of the vehicle, depending on directional rotation. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (D.7)
133. Technician A says lack of lubricant can seize the kingpin, causing hard steering. Technician B says to remove the tie rod end from the kingpin assembly to check kingpin pivot movement and ease of travel. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.1.5)

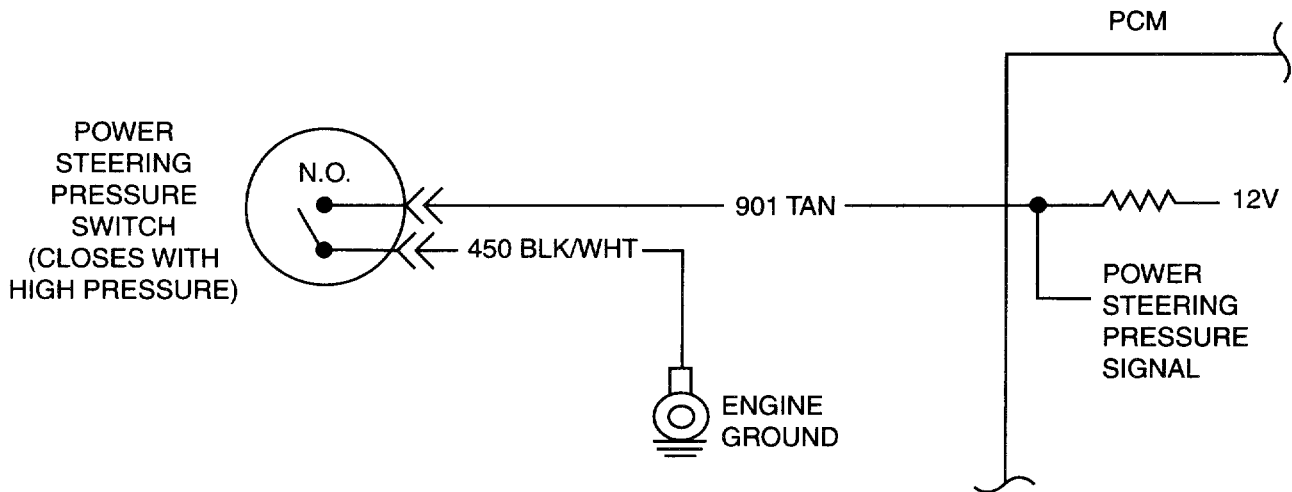


134. Referring to the figure, Technician A says when replacing the rear spindle, the shim may have to be re-used. Technician B says a four-wheel alignment is recommended, beginning with the rear. Who is right?
- A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
- (B.2.8)
135. During a four-wheel alignment, it was determined the left rear measurements are beyond maximum specifications, with no provisions for adjustments. The technician should:
- A. inspect the left rear spindle/strut assembly for damage.
  - B. install whatever shims are necessary, regardless of quantity.
  - C. compensate with front wheel adjustments.
  - D. rotate the tires and re-inspect in 3,000 miles.
- (B.2.8)
136. When installing a new tire on a wheel, all the following are true EXCEPT:
- A. Clean the sealing surface of the wheel.
  - B. Inflate the tire to manufacturer's specifications located on the door placard.
  - C. Mark the position of the wheel weights prior to removing old tire.
  - D. Use appropriate tire changing equipment adapters or accessories when servicing aluminum or other custom wheels.
- (D.7)

137. Excess kingpin movement is most likely to cause:  
 A. the steering gear lubricant to leak.  
 B. a vibration.  
 C. steering wander or pull.  
 D. excessive steering wheel effort. (B.1.5)
138. When dismounting and mounting a tire on a wheel, it is recommended to:  
 A. use an approved tire bead lubricant.  
 B. mount both beads simultaneously.  
 C. overinflate to seat stubborn beads.  
 D. dismount the tire using only a prybar. (D.7)



139. Refer to the schematic shown. Technician A says if the power steering pressure switch fails to close with high power steering pressure, the engine may stall. Technician B says if the power steering pressure switch is shorted, there will be 12V on CFT901. Who is right?  
 A. A only  
 B. B only  
 C. Both A and B  
 D. Neither A nor B (A.2.19)
140. The right rear spindle has been replaced on a front-wheel-drive vehicle. The technician should:  
 A. perform a front wheel alignment.  
 B. perform a four-wheel alignment starting with the rear.  
 C. replace all the struts.  
 D. bleed the power steering system. (B.2.8)
141. When inspecting the kingpins, excess inward and outward movement was detected. The most likely cause could be:  
 A. a bent I-beam.  
 B. the lower ball joint is worn.  
 C. the kingpin bushings are worn.  
 D. kingpin inclination (KPI) is out of adjustment. (B.1.5)



142. Refer to the figure shown. Using a scan tool, the serial data shows the power steering pressure reads high with the wheels straight ahead, at normal idle. The most likely cause is:

- A. a shorted power steering pressure switch.
- B. an open power steering pressure switch.
- C. an open in CFT 901.
- D. an open in the ground CFT 450.

(A.2.19)

# 7

## Appendices

### Answers to the Test Questions for the Sample Test Section 5

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- |       |       |       |       |
|-------|-------|-------|-------|
| 1. C  | 19. A | 37. B | 55. A |
| 2. C  | 20. A | 38. A | 56. A |
| 3. D  | 21. C | 39. B | 57. D |
| 4. D  | 22. A | 40. C | 58. C |
| 5. C  | 23. C | 41. C | 59. B |
| 6. B  | 24. C | 42. A | 60. C |
| 7. B  | 25. B | 43. C | 61. D |
| 8. D  | 26. D | 44. A | 62. C |
| 9. C  | 27. C | 45. A | 63. A |
| 10. D | 28. C | 46. C | 64. B |
| 11. B | 29. B | 47. B | 65. C |
| 12. A | 30. A | 48. A | 66. D |
| 13. D | 31. D | 49. B | 67. C |
| 14. A | 32. B | 50. A | 68. B |
| 15. B | 33. A | 51. C | 69. A |
| 16. B | 34. A | 52. A |       |
| 17. B | 35. C | 53. A |       |
| 18. B | 36. D | 54. A |       |

## Explanations to the Answers for the Sample Test Section 5

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### Question #1

Answer A is wrong. Remove the hoses and cap the lines right before removing the retaining bolts so that the fluid does not leak during the procedure.

Answer B is wrong. The belt must be removed before removing the mounting bolt.

**Answer C is correct.** Draining the fluid eliminates uncontrolled spilling during removal.

Answer D is wrong. The fluid must be drained from the system before removing the pump.

### Question #2

Answer A is wrong. Technician B is also right; the rack must be held while loosening the inner tie rod ends because they are threaded onto the rack.

Answer B is wrong. Technician A is also right; reduced articulation effort usually indicates worn tie rod ends.

**Answer C is correct.** Refer to specifications for any allowable movement. When these parts are worn, there is no service, except to replace them. If the rack is not held while loosening the inner tie rod ends, the rack can twist, causing internal damage.

Answer D is wrong. Both Technicians A and B are right.

### Question #3

Answer A is wrong. It is not possible to remove the steering gear first; there are other components that have to be removed first.

Answer B is wrong. This is not the easiest accessible component to disconnect.

Answer C is wrong. The steering-gear-to-frame mounts should be the last thing to be disconnected.

**Answer D is correct.** Disconnecting the battery cable will prevent problems while removing the steering gear, especially if working in the vicinity of the starter motor, or other "live" feeds.

### Question #4

Answer A is wrong. Setback is either a design feature of the vehicle or caused by collision damage.

Answer B is wrong. Vehicles designed with setback do not suffer steering pull.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.**

### Question #5

Answer A is wrong. Technician B is also right; the excessive free play could be caused by loose steering gear mounting bolts.

Answer B is wrong. Technician A is also right; the excessive free play could be caused by a worn flexible coupling.

**Answer C is correct.** Carefully inspect mounting bolts and check for proper torque, in addition to the condition of the flexible (U-joints) coupling. There also may be a noise while moving the steering wheel.

Answer D is wrong. Both Technicians A and B are right.

### Question #6

Answer A is wrong. Worn ball joints do not usually cause hard steering.

**Answer B is correct.** Tight rack bearings increase drag on the rack and can cause hard steering.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.



## Question #7

Answer A is wrong. Linear rate springs do not have a difference in space between the coils.

**Answer B is correct.** Coil spacing varies on variable-rate springs.

Answer C is wrong. Heavy-duty springs have thick coils or an additional helper spring in the center.

Answer D is wrong. The spring shown is not an adjustable coil spring. There is no such thing.

## Question #8

Answer A is wrong. A broken center bolt in the leaf spring could cause the alignment angles to vary, causing a pull.

Answer B is wrong. The vehicle will lead to the side with the least amount of caster.

Answer C is wrong. A pull will occur if the tire pressures are not set properly.

**Answer D is correct.** Excessive toe-in causes feathered tire wear, but this problem does not affect steering pull.

## Question #9

Answer A is wrong. Technician B is also right; some cradles have an alignment hole that must be matched to a corresponding hole in the chassis.

Answer B is wrong. Technician A is also right; several measurement points usually exist to determine cradle position and integrity.

**Answer C is correct.** Various manufacturers have published measurement procedures and specifications. If adjustments cannot be made within normal travel limits, it will be necessary to perform cradle measurements or alignment.

Answer D is wrong. Both Technicians A and B are right.

## Question #10

Answer A is wrong. Most vehicles need to be raised on the hoist to access the worm shaft; perform all operations that can be done with the vehicle on the ground first.

Answer B is wrong. The vehicle must be raised to access the Pitman arm.

Answer C is wrong. The hoses from the power steering pump must be disconnected first.

**Answer D is correct.** It is easier to remove and cap lines before removing the steering gear.

## Question #11

Answer A is wrong. The cotter keys are removed after disconnecting the steering column joint from the steering gear pinion.

**Answer B is correct.** Eliminates improper mating during reassembly.

Answer C is wrong. Depending on the application, the stabilizer links may not have to be disconnected.

Answer D is wrong. Removing the steering gear mounting bolts is the last step when removing the steering gear.

## Question #12

**Answer A is correct.** Closing the valve for longer than 10 seconds can cause excessive pressure, damaging the pump.

Answer B is wrong.

Answer C is wrong.

Answer D is wrong.

## Question #13

Answer A is wrong. The pump driveshaft does not pass through the joint between the reservoir and the pump housing.

Answer B is wrong. A restricted return hose would not cause the leak described in the question.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.** Because A and B are wrong, D is correct. An inspection of the housing and seals may be in order.

## Question #14

**Answer A is correct.** If suspension components are mounted to the cradle, a bent cradle could cause this difference.

Answer B is wrong. Worn steering gear mounting bushings do not influence the included angle.

Answer C is wrong. Wheel bearings have nothing to do with included angles.

Answer D is wrong. Tie rods have no effect on included angles.

## Question #15

Answer A is wrong. Since the rear wheels are misaligned, it would not cause the steering to wander.

**Answer B is correct.** The rear wheels are offset to point left, which forces the front to the right.

Answer C is wrong. Since the front suspension is aligned, returnability would not be affected.

Answer D is wrong. The pull would occur to the right.

## Question #16

Answer A is wrong. A loose belt does not cause the feel of "looseness" in the steering.

**Answer B is correct.** Loose preload adjustment can cause excessive steering wheel play.

Answer C is wrong. A scored steering gear cylinder would cause tightness in the steering.

Answer D is wrong. Low fluid level does not cause the feel of "looseness."

## Question #17

Answer A is wrong. To properly align the castellation nut, torque the nut. Then tighten the nut to align the cotter key hole with nut castellations.

**Answer B is correct.** This prohibits the rubber bushing from becoming distorted prior to vehicle weight placed on bushing after torquing.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

## Question #18

Answer A is wrong. There are no spacers between the inner tie rod and the rack and pinion.

**Answer B is correct.**

Answer C is wrong. There are no shock dampeners on the power rack and pinion.

Answer D is wrong. The inner rack seal cannot be seen in this illustration.

## Question #19

**Answer A is correct.** A binding and releasing action is a symptom of a faulty strut mount.

Answer B is wrong. Ball joints do not usually bind.

Answer C is wrong. Only Technician A is right.

Answer D is wrong. Technician A is right.

## Question #20

**Answer A is correct.** The tool shown is used to compress the coil springs on a long-and-short arm suspension system.

Answer B is wrong. There is no tool used to position the shock absorber.

Answer C is wrong. The ball joint movement is measured with a dial indicator.

Answer D is wrong. Lower control arm bushing wear is simply visually inspected.

## Question #21

Answer A is wrong. When a tire is overinflated, the center of the tread expands, causing wear in the center of the tire.

Answer B is wrong. When a tire is underinflated, the weight of the vehicle is positioned on the sidewall, causing wear to the sides.

**Answer C is correct.** Tire pressure should be adjusted when the tires are cold.

Answer D is wrong. Damage can occur to the tire and the wheel when tire inflation is below the specified pressure.

## Question #22

**Answer A is correct.** A worn strut rod bushing would not affect body sway while cornering.  
Answer B is wrong. Stabilizer bars control body roll; if they are weak, this would cause a problem.  
Answer C is wrong. A worn stabilizer bar bushing would cause excessive play between the stabilizer bar and the bushing that would translate into body roll.  
Answer D is wrong. If a stabilizer bar link is broken, the sway bar could not function properly.

## Question #23

Answer A is wrong. Although Technician A is right, Technician B is also right; if an air-assisted shock absorber slowly loses pressure, it may need replacement. If air lines to the shock were leaking, the shock probably would not be pressurized to begin with.  
Answer B is wrong. Although Technician B is right, Technician A is also right; many air-assisted shock absorbers can be pressurized with the shop air supply.  
**Answer C is correct.** Both Technicians A and B are correct.  
Answer D is wrong. Both Technicians A and B are right.

## Question #24

Answer A is wrong. Technician B is also right.  
Answer B is wrong. Technician A is also right.  
**Answer C is correct.** The part number helps identify proper orientation during installation. The bearing preload must be adjusted, as it may change during any disassembly or when any new parts are installed.  
Answer D is wrong. Both Technicians A and B are right.

## Question #25

Answer A is wrong. Misalignment of the rack would cause toe-angle alignment problems, but not returnability problems.  
**Answer B is correct.** Overly tight rack bearings could restrict rack movement and cause returnability problems.  
Answer C is wrong. Only Technician B is right.  
Answer D is wrong. Technician B is right.

## Question #26

Answer A is wrong. The control unit shuts off the power to the rear steering unit when in fail-safe mode.  
Answer B is wrong. The control unit energizes the damper relay to center the rear steering.  
Answer C is wrong. The damper unit will slowly center the rear steering.  
**Answer D is correct.** The control unit will light the 4WS lamp in fail-safe mode.

## Question #27

Answer A is wrong. Technician B is also right.  
Answer B is wrong. Technician A is also right.  
**Answer C is correct.** Foaming indicates air is still in the system. Holding in position for two or three seconds stabilizes pressure, forces air.  
Answer D is wrong. Both Technicians A and B are right.

## Question #28

Answer A is wrong. Technician B is also right.  
Answer B is wrong. Technician A is also right.  
**Answer C is correct.** Worn bushings can cause suspension geometry changes. Many torsion bar suspension systems can be adjusted to compensate for wear.  
Answer D is wrong. Both Technicians A and B are right.

## Question #29

Answer A is wrong. The power steering assist is increased only at low vehicle speeds; at higher speeds the assist is reduced.

**Answer B is correct.** The system recognizes steering wheel speed (rate or change) and varies the amount of assist the system will provide, therefore reducing effort.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

## Question #30

**Answer A is correct.** Excessive toe-out on the left rear wheel will position the thrust angle to the left of the geometric centerline.

Answer B is wrong. Excessive toe-out on the right rear wheel will position the thrust angle to the right of the geometric centerline.

Answer C is wrong. Positive camber will not place the thrust angle out of allowable specifications.

Answer D is wrong. Wear in a rear ball joint should not place the thrust angle out of allowable specifications.

## Question #31

Answer A is wrong. If a safety stand was placed under the chassis, the ball joint would still be loaded.

Answer B is wrong. Disconnecting the shock would not unload the ball joint.

Answer C is wrong. Ride height does not affect ball joint load.

**Answer D is correct.** Until the safety stand is placed under the lower control arm, the spring is working against the ball joint stud. With the stand in place, the load is transferred to the stand (in place of the tire) where accurate ball joint inspection can be made.

## Question #32

Answer A is wrong. Usually if the steering gear requires adjustment, it is not because the vehicle experiences bump steer.

**Answer B is correct.** In this situation, the bent pitman arm causes unequal toe changes that occur as the suspension travels through jounce and rebound, resulting in sudden veering.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

## Question #33

**Answer A is correct.**

Answer B is wrong. This tie rod does not affect camber.

Answer C is wrong. The longer-than-normal tie rod would cause wear on the inside edge of the tire.

Answer D is wrong. Excessive toe-out on the left rear wheel will not cause a pull to the right.

## Question #34

**Answer A is correct.**

Answer B is wrong. Neither ride height nor spring condition affects tire wear, in this rear situation.

Answer C is wrong. Since this problem is in the rear of the vehicle, there would be no effect on the steering wheel.

Answer D is wrong. A sagged rear spring would not affect front tire wear.

## Question #35

Answer A is wrong. Technician B is also right; a bent relay rod can cause the toe angle to change, resulting in feather-edged tire wear.

Answer B is wrong. Technician A is also right; a bent relay rod will change the front wheel toe angle, resulting in feather-edged tire wear.

**Answer C is correct.** A bent relay rod will change the front wheel toe angle, resulting in feather-edged tire wear.

Answer D is wrong. Both Technicians A and B are right.

## Question #36

Answer A is wrong. Suspension parts should not be filed, cut, ground, or otherwise tampered with to make alignment adjustments. The only case in which modification is permitted is when the part was made originally with a knockout plug or similar provision for modification.

Answer B is wrong. Upper strut mounting holes in the car body should not be filed, cut, ground, or otherwise tampered with to make alignment adjustments. Some aftermarket strut mounting plates can be installed that provide elongated holes for alignment adjustments.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.**

## Question #37

Answer A is wrong. Placing the shim on the front spindle bolts would increase the left rear wheel toe-out.

**Answer B is correct.** If the rear wheel(s) are offset to the left, it will cause the front to pull right.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

## Question #38

**Answer A is correct.** During braking, a worn strut bushing would cause a rapid caster change.

Answer B is wrong. Negative caster would cause a pull, regardless of braking action.

Answer C is wrong. Only Technician A is right.

Answer D is wrong. Technician A is right.

## Question #39

Answer A is wrong. Excessive toe-out can only cause tire wear.

**Answer B is correct.** Imbalance of the tire/wheel assembly will cause a shimmy or vibration.

Answer C is wrong. Setback angles cannot cause shimmies or vibration.

Answer D is wrong. Camber angles do not cause shimmy.

## Question #40

Answer A is wrong. Answer B is also correct.

Answer B is wrong. Answer A is also correct.

**Answer C is correct.** These components dampen road induced vehicle movement and maintain correct ride height.

Answer D is wrong. Both Technicians A and B are right.

## Question #41

Answer A is wrong. Worn ball joints could cause excessive play in the steering, but not excessive effort.

Answer B is wrong. Weak front springs would only affect the ride height of the vehicle.

**Answer C is correct.** A seized idea arm will add resistance and increase steering effort.

Answer D is wrong. A weak stabilizer bar would only affect the ride quality of the vehicle.

## Question #42

**Answer A is correct.** The inner rack seal is leaking.

Answer B is wrong. The location shown is nowhere near the pinion shaft.

Answer C is wrong. The location shown is the inner rack seal.

Answer D is wrong. The input shaft is the same as the pinion shaft.

## Question #43

Answer A is wrong. Worn struts could affect ride height.

Answer B is wrong. Damaged upper strut mounts could affect ride height.

**Answer C is correct.** The steering gear mounting bushing has no effect on the ride height.

Answer D is wrong. Worn control arm bushings could affect ride height.

## Question #44

**Answer A is correct.** If the head touches the bracket, it increases the shear load.

Answer B is wrong. If the bolt head is touching the bracket, the load is too high.

Answer C is wrong. Only Technician A is right.

Answer D is wrong. Technician A is right.

## Question #45

**Answer A is correct.**

Answer B is wrong. A vehicle will pull to the side with the least amount of caster.

Answer C is wrong. Excessive toe-in will not cause a vehicle to pull to one side.

Answer D is wrong. Improper toe-out on the right front wheel while turning would not cause the vehicle to pull.

## Question #46

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** The movement of either or both the rod adjusting sleeves will cause the toe adjustment to change. It is possible to have correct toe angles and the steering wheel off center. The opposite is also true, whereby the steering wheel is centered. But, the toe angle is incorrect. The objective is to center the steering wheel, then adjust the toe as necessary using the tie rod sleeve(s).

Answer D is wrong.

## Question #47

Answer A is wrong. Scored power steering gear cylinders cannot transmit road shock.

**Answer B is correct.** The damper is to absorb road induced movement.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

## Question #48

**Answer A is correct.** This results in the symptom known as bump steer.

Answer B is wrong. Caster adjustment would not affect the driveability of the vehicle if it hit a bump.

Answer C is wrong. Worn upper strut mounts would only cause noises when cornering.

Answer D is wrong. Worn front struts cause a floating ride quality.

## Question #49

Answer A is wrong. Poor returnability would not be caused by a loose rack bearing adjustment.

**Answer B is correct.**

Answer C is wrong. Loose steering gear mounting bolts would cause a clunk when cornering. That would not usually cause poor returnability.

Answer D is wrong. Excessive positive camber would only cause tire wear.

## Question #50

**Answer A is correct.** The standard for belt tension is that for every one foot of free span, the deflection should be 0.5 in. (12.7mm). Answers B, C and D are all too loose. The specifications take into consideration proper belt ride with variances in temperature and speed.

Answer B is wrong.

Answer C is wrong.

Answer D is wrong.

## Question #51

Answer A is wrong. Technician B is also right; a restricted high-pressure hose can reduce pressure at the steering gear even when the pump is developing full pressure.

Answer B is wrong. Technician A is also right; a defective power steering gear can cause excessive steering effort even with proper hydraulic pressure.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

Question #52

**Answer A is correct.** The system must be active in order for the scan tester to read data.  
 Answer B is wrong. Damage to the air suspension springs can occur if the switch is not turned off.  
 Answer C is wrong. When hoisting the vehicle, the air suspension switch must be turned off.  
 Answer D is wrong. The air suspension should be turned off any time the vehicle is towed.

Question #53

**Answer A is correct.** Camber and toe is read with wheels straight ahead.  
 Answer B is wrong. The front wheels must be turned left and right to measure caster.  
 Answer C is wrong. The brakes are applied so that the adjustments do not change while the retaining bolts are loose.  
 Answer D is wrong. Before checking caster, the suspension system must be settled by jouncing the vehicle's front suspension.

Question #54

**Answer A is correct.** The strut or shock absorber is designed to smooth out road-induced movement and body bounce.  
 Answer B is wrong. Coil springs do not dampen oscillations; that is the job of the strut or shock absorber.  
 Answer C is wrong. Only Technician A is right.  
 Answer D is wrong. Technician A is right.

Question #55

**Answer A is correct.** A bent steering arm can change the radius, resulting in a change in the toe-out on turning distance.  
 Answer B is wrong. Caster would not make the tire squeal when cornering.  
 Answer C is wrong. Stabilizer bar bushings have no effect on the steering geometry.  
 Answer D is wrong. Struts would have no effect on the steering geometry.

Question #56

**Answer A is correct.**  
 Answer B is wrong. The sector shaft has to have some amount of preload placed on it.  
 Answer C is wrong. 20 in. lbs. is too high for sector shaft preload.  
 Answer D is wrong. If the sector shaft preload were 5 ft. lbs., it would be difficult to turn the steering wheel.

Question #57

Answer A is wrong. Loose worm bearing preload would cause the steering effort to be minimal, not excessive.  
 Answer B is wrong. An overfilled steering gear would not affect steering effort.  
 Answer C is wrong. Minimal caster reduces steering effort.  
**Answer D is correct.**

Question #58

Answer A is wrong. Technician B is also right; a bent rear wheel can cause rear "waddle."  
 Answer B is wrong. Technician A is also right; a defective belt in a rear tire can cause rear "waddle."  
**Answer C is correct.**  
 Answer D is wrong. Both Technicians A and B are right.

Question #59

Answer A is wrong. The front wheels must be aligned while in the straight-ahead position.  
**Answer B is correct.** Toe is adjusted *after* caster and camber.  
 Answer C is wrong. After setting the toe, the clear vision for the steering wheel is properly adjusted.  
 Answer D is wrong. Tie rod sleeves can become rusted or corroded; the use of a rod sleeve adjusting tool can help.

## Question #60

Answer A is wrong. Technician B is also right; the spring must be fully compressed before loosening the strut rod nut.

Answer B is wrong. Technician A is also right; the spring should be taped to protect it and to help keep the spring from slipping in the compressor.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #61

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** The fluid has to be at the specified temperature. Hotter fluid expands, thus needs to be inspected in normal operation conditions.

## Question #62

Answer A is wrong. The power steering pump pulley is removed with a puller that fits into the groove on the pulley.

Answer B is wrong. Removing a bolt-on pulley does not require a special tool.

**Answer C is correct.** This insures the pulley is not cocked.

Answer D is wrong. An impact wrench is all that is needed to loosen the power steering pump pulley bolt.

## Question #63

**Answer A is correct.**

Answer B is wrong. Coil springs do not dampen oscillations.

Answer C is wrong. A broken spring insulator would only cause noises when the suspension is jounced.

Answer D is wrong. Stabilizer bars only control body roll; a worn bushing would not affect the jounce ability.

## Question #64

Answer A is wrong. A worn lower ball joint cannot affect the turning radius.

**Answer B is correct.** This can change toe-out on turns.

Answer C is wrong. A worn lower control arm bushing would only be noticeable in the form of a noise.

Answer D is wrong. Stabilizer bushings have no effect on the turning radius of the vehicle.

## Question #65

Answer A is wrong. Broken coil springs often make a rattling noise.

Answer B is wrong. If a coil spring insulator were torn or missing, the coil spring touching the axle would make a rattling noise.

**Answer C is correct.** A belt strut is not loose, but rather distorted. It will not make noise.

Answer D is wrong. If the bushing were worn, there could be metal-to-metal contact causing a rattling noise.

## Question #66

Answer A is wrong. Camber does not feather the tread.

Answer B is wrong. Caster angle does not cause tire wear.

Answer C is wrong. Setback does not cause tire wear.

**Answer D is correct.** Toe adjustment not as specs will cause the tire to "scrub" sideways.

## Question #67

Answer A is wrong. Technician B is also right; tire conicity definitely can cause the vehicle to pull.

Answer B is wrong. Technician A is also right; different tread patterns on the front tires can cause the vehicle to pull.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.



Question #68

Answer A is wrong. Excessive positive camber does not increase steering effort, and it has only a negligible effect on steering return.

**Answer B is correct.** Reduced rear ride height has the effect of increasing positive caster on the front wheels, which could cause the symptoms described.

Answer C is wrong. Only Technician B is right.

Answer D is wrong. Technician B is right.

Question #69

**Answer A is correct.** Tire balance does not affect steering wheel return.

Answer B is wrong. When a tire is unbalanced, it begins to bounce and does not contact the road surface evenly, causing cupped tire wear.

Answer C is wrong. When the tire is unbalanced, the vibrations can be transmitted through the steering linkage into the steering wheel.

Answer D is wrong. Vibrations that are caused from unbalanced tires can cause premature steering linkage wear.

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## Answers to the Test Questions for the Additional Test Questions Section 6

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1. B	37. A	73. C	109. C
2. B	38. C	74. D	110. A
3. B	39. A	75. D	111. C
4. B	40. C	76. A	112. A
5. C	41. B	77. D	113. A
6. C	42. A	78. C	114. C
7. D	43. C	79. A	115. D
8. C	44. A	80. A	116. D
9. A	45. C	81. A	117. C
10. C	46. B	82. A	118. D
11. D	47. C	83. B	119. A
12. A	48. C	84. C	120. C
13. C	49. A	85. B	121. A
14. C	50. A	86. C	122. A
15. C	51. D	87. C	123. B
16. C	52. B	88. C	124. C
17. C	53. C	89. D	125. C
18. D	54. B	90. C	126. D
19. B	55. C	91. B	127. C
20. B	56. C	92. C	128. C
21. C	57. B	93. D	129. D
22. B	58. A	94. A	130. A
23. C	59. B	95. C	131. D
24. C	60. B	96. D	132. C
25. A	61. D	97. D	133. C
26. C	62. C	98. C	134. C
27. C	63. C	99. D	135. A
28. C	64. B	100. A	136. C
29. A	65. C	101. D	137. C
30. C	66. D	102. A	138. A
31. A	67. D	103. A	139. A
32. C	68. B	104. C	140. B
33. A	69. D	105. C	141. C
34. C	70. C	106. B	142. A
35. A	71. D	107. A	
36. D	72. D	108. D	

## Explanations to the Answers for the Additional Test Questions Section 6

### Question #1

Answer A is wrong. The system does just the opposite; the steering effort is decreased for parking purposes.  
**Answer B is correct.** Firmer steering can help give the feeling of more stability. The higher the speed, the more effort is required.

Answer C is wrong.

Answer D is wrong.

### Question #2

Answer A is wrong. Spring insulators should be placed on the springs.

**Answer B is correct.** Variable rate springs are designed to deflect or compress more slowly as additional weight is added. The weight and compression ratio are inversely proportionate to the limit of the spring. The close convolutions are at the top, to give good ride characteristics with normal weight.

Answer C is wrong. Closed coils should be at the top.

Answer D is wrong. Springs should be placed with the ends about one half inch from their stops.

### Question #3

Answer A is wrong. All power steering rack-and-pinion assemblies need adjustment.

**Answer B is correct.** All rack-and-pinion systems have several adjustments that need to be checked, regardless of power or manual systems.

Answer C is wrong.

Answer D is wrong.

### Question #4

Answer A is wrong. Camber adjustments can be made by adding shims.

**Answer B is correct.** It is never recommended to heat and/or bend a steering or suspension component. Doing so can alter the designed strength specifications.

Answer C is wrong. Camber adjustments can be made by installing cams.

Answer D is wrong. Camber adjustments can be made by installing eccentrics.

### Question #5

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Either situation could have resulted in misaligned components.

Answer D is wrong.

### Question #6

Answer A is wrong. Technician B is also right; oil-soaked mounting bushings can let the rack shift on the frame and cause the noise described.

Answer B is wrong. Technician A is also right; dried-out and loose mounting bushings can let the rack shift on the frame and cause the noise described.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

### Question #7

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** Changing the tire position on the wheel, or wheel to hub, can help runout. Tire and wheel sizes are proportionate to vehicle size and weight.

## Question #8

Answer A is wrong. Ball joints should be inspected within the steering system.

Answer B is wrong. Tires should be inspected along with the steering system.

**Answer C is correct.** A rack-and-pinion steering system does not have a Pitman arm.

Answer D is wrong. Tie rods should be inspected as part of the steering system.

## Question #9

**Answer A is correct.** Shock absorbers do not affect ride height.

Answer B is wrong. A broken coil spring will alter ride height.

Answer C is wrong. A misadjusted torsion bar will alter ride height.

Answer D is wrong. A weak or sagging leaf spring will alter ride height.

## Question #10

Answer A is wrong. Technician B is also right; worn or loose mounting bushings can let the rack shift on the frame and reduce steering control.

Answer B is wrong. Technician A is also right; reduced caster (close to zero degrees) can cause the vehicle to dart and wander and perhaps pull to one side if caster is unequal.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #11

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** The adjustment is for assembly and manufacturing variables, and allows the center link to be level.

## Question #12

**Answer A is correct.** This process is a typical service operation and will thoroughly flush and bleed the system of air.

Answer B is wrong. Never use solvent to clean the power steering system. Solvent cannot lubricate the pump rotors, which will cause damage to the pump.

Answer C is wrong.

Answer D is wrong.

## Question #13

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Either condition will cause the steering wheel to be off-center.

Answer D is wrong.

## Question #14

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Eye bushings can wear due to age and prolonged twisting action associated with normal use. In addition, the separators can shift or wear. Either condition can cause irregular spring movement and possible noise.

Answer D is wrong.

## Question #15

Answer A is wrong. Caster may be adjusted by adding shims.

Answer B is wrong. Caster may be adjusted by lengthening or shortening the strut rod.

**Answer C is correct.** Torsion bar adjusting bolt is used to adjust ride height.

Answer D is wrong. Caster may be adjusted by turning the eccentric cams.

Question #16

Answer A is wrong. Deflection is specified to belt length between pulleys.

Answer B is wrong.

**Answer C is correct.** A belt tension gauge is the best way to assure proper belt tension.

Answer D is wrong. Can damage components.

Question #17

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** At regular recommended intervals, rotating tires can help in wearing all the tires at an equal rate. Some tires may need to be kept on the same side of the vehicle (directional rotation type), while others can be moved side to side.

Answer D is wrong.

Question #18

Answer A is wrong. Using sealer is not the proper way to repair a bellows boot.

Answer B is wrong. Ignoring the problem will not fix it.

Answer C is wrong. Dirt and moisture may have entered the inner tie rod.

**Answer D is correct.** This determines the condition of the inner tie rod.

Question #19

Answer A is wrong. When the included angle is not within specifications, tire wear will occur and the handling will be poor.

**Answer B is correct.** This angle can also change the scrub radius, thus changing the tire wear and handling characteristics of the vehicle.

Answer C is wrong.

Answer D is wrong.

Question #20

Answer A is wrong.

**Answer B is correct.** The steering wheel needs to be centered in relationship to the equal number of turns from center to lock, left and right. Other adjustments are also based off of this reference such as steering gear preload.

Answer C is wrong.

Answer D is wrong.

Question #21

Answer A is wrong. The sector shaft should be checked for wear.

Answer B is wrong. The gear housing should be checked for wear.

**Answer C is correct.** The rack piston is found on rack-and-pinion steering only.

Answer D is wrong. The Pitman arm should be checked for wear.

Question #22

Answer A is wrong. Misadjusted tie rod ends will affect toe.

**Answer B is correct.** Toe is an adjustment of linkage outside the steering gearbox.

Answer C is wrong. A bent center link will affect toe.

Answer D is wrong. A bent Pitman arm will affect toe.

Question #23

Answer A is wrong. A broken leaf spring would cause a clunk or a thud instead of a rattle.

Answer B is wrong. Missing insulators would cause a squeaking noise.

**Answer C is correct.** A broken shackle is most likely to cause a rattle.

Answer D is wrong. A broken center bolt would produce a loud thump while hitting bumps.

Question #24

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Struts, like shock absorbers, need to be replaced if they allow too much body bounce or travel. The oil needs to be reused or replaced with new struts to aid in heat dissipation and lubrication.

Answer D is wrong.

Question #25

**Answer A is correct.** Other nonadjustable angles affect scrub radius and toe-out on turns.

Answer B is wrong. Steering axis inclination must be checked; this is a nonadjustable angle that is only changed when the spindles are replaced.

Answer C is wrong.

Answer D is wrong.

Question #26

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Effects scrub radius, toe-out on turns, and driveline component alignment, respectively.

Answer D is wrong.

Question #27

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Flexible couplings are used for differences in the steering column angle and the steering gear shaft. If the coupling becomes loose or worn, loose steering or excessive play will result.

Answer D is wrong.

Question #28

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Visual inspections can detect components that need service prior to alignment.

Answer D is wrong.

Question #29

**Answer A is correct.**

Answer B is wrong. The shock absorber is holding the suspension in position, and if it is disconnected without supporting the lower control arm, the suspension will drop.

Answer C is wrong. The suspension should be supported first.

Answer D is wrong. Before the lower portion of the shock is disconnected, the suspension must be supported.

Question #30

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** The tires chosen for a particular vehicle are matched for weight and performance requirements, including temperature and load considerations. Incorrect sizes can effect handling, heat dissipation, tire wear, and load capacity.

Answer D is wrong.

Question #31

**Answer A is correct.**

Answer B is wrong. While the vehicle is standing overnight, it will probably leak down, and the technician still will not know where the leak is.

Answer C is wrong.

Answer D is wrong.

Question #32

Answer A is wrong. The outer tie rod end must be removed to remove the bellows boot.

Answer B is wrong. The outer tie rod end must be removed to install the special tool.

**Answer C is correct.**

Answer D is wrong. The wheel and tire assembly does not have to be removed.

Question #33

**Answer A is correct.**

Answer B is wrong. Water-based lubricant will not furnish enough lubrication for the seals.

Answer C is wrong. Petroleum-based lubricants could damage the seals.

Answer D is wrong. Chassis grease could damage the seals.

Question #34

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Variations in temperature, altitude, and pressure can vary the pressure in the air suspension system. Slight variations are considered normal.

Answer D is wrong.

Question #35

**Answer A is correct.** Incorrect SAI can prevent accurate camber adjustment.

Answer B is wrong. Elongating the adjustment holes could weaken the frame.

Answer C is wrong.

Answer D is wrong.

Question #36

Answer A is wrong. A light oil film on the shock is normal.

Answer B is wrong. A bounce test alone is not accurate.

Answer C is wrong.

**Answer D is correct.**

Question #37

**Answer A is correct.**

Answer B is wrong. Geometric centerline is part of the vehicle's design and cannot be adjusted.

Answer C is wrong.

Answer D is wrong.

Question #38

Answer A is wrong. Technician B is also right; SAI correction requires replacement of damaged parts.

Answer B is wrong. Technician A is also right; SAI problems may require correction before camber can be adjusted.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

Question #39

**Answer A is correct.**

Answer B is wrong. No steering gear adjustment is needed after adjusting toe.

Answer C is wrong. The steering wheel should be centered before adjusting toe.

Answer D is wrong. There is no idler arm on a rack-and-pinion system.

Question #40

Answer A is wrong. Technician B is also right; the height sensor adjustment may have slipped.

Answer B is wrong. Technician A is also right; the height sensor may be disconnected.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #41

Answer A is wrong. If fluid is leaking from the thread fitting, tighten the fitting.

**Answer B is correct.** There is no repair for this type of assembly, except replacement.

Answer C is wrong. If the hose is transmitting noise, move the hose so that it does not touch the body.

Answer D is wrong. A heavy-duty hose can be used on a light application; the hose will just last longer.

## Question #42

**Answer A is correct.** Turning the toe adjusting sleeves equal amounts in the same direction will turn the steering wheel without changing the toe angle.

Answer B is wrong. Repositioning the steering wheel without compensating the toe adjustment sleeves can leave the steering gear off its high point and mask other problems with tie rods and other toe adjusting components.

Answer C is wrong.

Answer D is wrong.

## Question #43

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** More and more later model vehicles have provisions for toe and camber adjustments in the rear. If provisions are not available or alterations are not recommended, replacement of spindles, flanges, or axles is sometimes necessary to correct toe or camber angles.

Answer D is wrong.

## Question #44

**Answer A is correct.**

Answer B is wrong. Disconnecting the ball joint with tension on the spring could cause personal injury.

Answer C is wrong. Bushings should never be lubricated with transmission oil.

Answer D is wrong. Supporting the weight of the vehicle by the lower control arm will not allow the spring to be removed easily.

## Question #45

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Various aftermarket solutions for these types of problems are now available. The vehicle manufacturer may also have introduced a retrofit kit to give provisions for adjustments, where none existed before.

Answer D is wrong.

## Question #46

Answer A is wrong. Running a tire under its specified pressure can damage the tire and is not recommended.

**Answer B is correct.** Tire lead is a common cause of steering pull and sometimes can be corrected by rotating tires.

Answer C is wrong.

Answer D is wrong.

## Question #47

Answer A is wrong. Technician B is also right; the wrong kind of fluid in a steering pump (brake fluid, motor oil, or other fluids) can damage pump seals.

Answer B is wrong. Technician A is also right; excessive play in the steering pump shaft can hammer on the seals and damage them.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.



Question #48

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** If the cradle cannot be centered or repositioned per manufacturer procedures, then specific measurements must be made, as per the points specified. If it is damaged, it will need to be replaced.

Answer D is wrong.

Question #49

**Answer A is correct.** A more thorough inspection of other components is needed, and actually should have been done in the first place.

Answer B is wrong. The seals have already been replaced twice; defective seals are unlikely.

Answer C is wrong.

Answer D is wrong.

Question #50

**Answer A is correct.** A leaking or dented steering damper will not work properly.

Answer B is wrong. High-speed vibration is not likely to be caused by a faulty steering damper. Other possible causes are more likely.

Answer C is wrong.

Answer D is wrong.

Question #51

Answer A is wrong. Location cannot be changed.

Answer B is wrong. Adjustment is made with normal vehicle weight on the ground.

Answer C is wrong.

**Answer D is correct.**

Question #52

Answer A is wrong. Heat should not be applied to a torsion bar.

**Answer B is correct.** Tension is changed by turning an adjusting bolt.

Answer C is wrong. Adding shims will not adjust the torsion bar.

Answer D is wrong. There are no brackets with offset.

Question #53

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Regardless of the method, the load must be removed from the ball joint to accurately check for wear. If not, a worn ball joint may be missed or overlooked because the weight of the load will make it seem tight.

Answer D is wrong.

Question #54

Answer A is wrong. Ride height does not affect included angle.

**Answer B is correct.** Camber angle is part of the sum of SAI.

Answer C is wrong. Thrust angle does not affect included angle.

Answer D is wrong. The springs will not correct included angle.

Question #55

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Worn strut bushings can cause a caster angle change, resulting in a pull problem.

Answer D is wrong.

## Question #56

Answer A is wrong. The technician must disconnect the tie rods.

Answer B is wrong. The technician must disconnect the mounting brackets.

**Answer C is correct.**

Answer D is wrong. The technician must disconnect the U-joint coupler.

## Question #57

Answer A is wrong. The rack seal bypassing would cause a lack of power assist in both directions.

**Answer B is correct.**

Answer C is wrong.

Answer D is wrong.

## Question #58

**Answer A is correct.**

Answer B is wrong. All tires have to be balanced no matter how much they cost.

Answer C is wrong.

Answer D is wrong.

## Question #59

Answer A is wrong. The boots on the rack do not have to be replaced just because they come in contact with power steering fluid; when the seals leak, the rack needs replacement.

**Answer B is correct.**

Answer C is wrong.

Answer D is wrong.

## Question #60

Answer A is wrong. A rack-and-pinion steering system does not have an idler arm.

**Answer B is correct.**

Answer C is wrong.

Answer D is wrong.

## Question #61

Answer A is wrong. Rear wheels should be adjusted before trying to adjust the front wheels.

Answer B is wrong. Ride height will not affect thrust angle.

Answer C is wrong. Rotating the tires will not correct thrust angle.

**Answer D is correct.**

## Question #62

Answer A is wrong. Technician B is also right; some struts must be replaced as a unit.

Answer B is wrong. Technician A is also right; some MacPherson struts have replaceable shock absorber cartridges.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #63

Answer A is wrong. Technician B is also right; excessive steering play also can be caused by a loose idler arm.

Answer B is wrong. Technician A is also right; worn tie rod ball sockets can cause excessive steering play.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #64

Answer A is wrong. Never use an impact wrench to remove the inner tie rods, as this can cause damage to the rack or other internal components due to the impact vibrations and torque.

**Answer B is correct.**

Answer C is wrong.

Answer D is wrong.

Question #65

Answer A is wrong. The lines should be routed away from moving components and exhaust.

Answer B is wrong. The fill valve should be mounted in an easily accessible location.

**Answer C is correct.** Unloaded, maximum air pressure in the shocks raises the ride height beyond specifications.

Answer D is wrong. The air shock should be installed before filling with air.

Question #66

Answer A is wrong. A defective power steering pump would affect steering assist at all speeds, but might be more noticeable at low speed.

Answer B is wrong. A defective steering wheel rotation sensor would affect steering boost more during parking and very little, or not at all, at high speed.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.** The explanations from both Technicians A and B are unlikely. The most likely cause of improper steering boost control as vehicle speed changes would be a defective vehicle speed sensor (VSS).

Question #67

Answer A is wrong. A shock absorber is part of a MacPherson strut suspension.

Answer B is wrong. A coil spring is part of a MacPherson strut suspension.

Answer C is wrong. The lower control arm is part of a MacPherson strut suspension.

**Answer D is correct.** There is no upper control arm on a MacPherson strut system.

Question #68

Answer A is wrong.

**Answer B is correct.** If the pressure is normal, but volume is low, there will be fluid starvation, resulting in lack of assist or component damage.

Answer C is wrong.

Answer D is wrong.

Question #69

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** The pulley must be installed to a proper depth distance specification. The pump does not have to be disassembled.

Question #70

Answer A is wrong. Replacing the struts will not necessarily correct caster.

Answer B is wrong. A technician should never heat and bend a suspension component.

**Answer C is correct.** Cradle, or subframe, misalignment is a common cause of incorrect caster.

Answer D is wrong. Thrust angle does not affect caster.

Question #71

Answer A is wrong. Measuring the wheelbase is not effective for finding a bent strut.

Answer B is wrong. Using a straightedge will not give an accurate measurement.

Answer C is wrong. Visually checking for a bent strut is not accurate.

**Answer D is correct.**

Question #72

Answer A is wrong. Caster does not wear tires.

Answer B is wrong. Toe-out causes more wear on the inside.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.**

## Question #73

Answer A is wrong. Technician B is also right; the rack-and-pinion mounting bracket may be bent, causing unequal tie rod angles and resultant bump steer.

Answer B is wrong. Technician A is also right; the rack-and-pinion mounting bushings may be worn, damaged, or otherwise defective.

**Answer C is correct.**

Answer D is wrong. Both Technicians A and B are right.

## Question #74

Answer A is wrong. Tapered roller bearings require a very slight preload to make the rollers roll.

Answer B is wrong. Tightening the spindle nut as much as possible by hand would be overtightening the nut and the bearings.

Answer C is wrong. Both Technicians A and B are wrong.

**Answer D is correct.**

## Question #75

Answer A is wrong. There is no caster adjustment for the rear wheels.

Answer B is wrong. There is no caster adjustment for the rear wheels.

Answer C is wrong. This sequence is incorrect.

**Answer D is correct.**

## Question #76

**Answer A is correct.** Preload adjustments are performed using various methods, depending on the manufacturer.

Answer B is wrong. The steering gear does not have to be drained to be adjusted.

Answer C is wrong.

Answer D is wrong.

## Question #77

Answer A is wrong. Cold fluid would not be aerated.

Answer B is wrong. The fluid cannot become aerated if the fluid is overheated.

Answer C is wrong. Engine speed cannot cause the power steering fluid to become aerated.

**Answer D is correct.**

## Question #78

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** This verifies pressure, flow, volume, and controls of the power steering system.

Answer D is wrong.

## Question #79

**Answer A is correct.**

Answer B is wrong. Draining the system will not help.

Answer C is wrong. Changing the flow control valve will cause more damage.

Answer D is wrong. There are no antifoaming additives for the power steering system.

## Question #80

**Answer A is correct.** The toe-in specification should be split left and right, for a total toe angle. This also helps ensure a centered steering wheel.

Answer B is wrong.

Answer C is wrong.

Answer D is wrong.

Question #81

**Answer A is correct.** A pulley will not bend through normal wear.  
 Answer B is wrong. A collision is a likely cause of a bent pulley.  
 Answer C is wrong. Using the pulley as a pry rest can cause it to bend.  
 Answer D is wrong. Striking the ground is a possible cause of a bent pulley.

Question #82

**Answer A is correct.**  
 Answer B is wrong. Using shims to align the power steering pulley is not an approved practice.  
 Answer C is wrong.  
 Answer D is wrong.

Question #83

Answer A is wrong. Bouncing the vehicle will not seat the spring.  
**Answer B is correct.** An alignment should always be performed after replacing most any steering or suspension part.  
 Answer C is wrong. The technician should never weld a strut.  
 Answer D is wrong.

Question #84

Answer A is wrong.  
 Answer B is wrong.  
**Answer C is correct.** There are no serviceable parts in this center link. Worn joints, elongated holes, or bends require replacing the center link.  
 Answer D is wrong.

Question #85

Answer A is wrong. A remote power supply will keep the air bag system energized.  
**Answer B is correct.** The lines can be disconnected and plugged.  
 Answer C is wrong.  
 Answer D is wrong.

Question #86

Answer A is wrong. Aligning the front wheels would not be done first.  
 Answer B is wrong. Shock absorber operation probably has nothing to do with the problem.  
**Answer C is correct.**  
 Answer D is wrong. The driveshaft balance is an unlikely cause and should be checked only if wheel balancing does not fix the problem.

Question #87

Answer A is wrong.  
 Answer B is wrong.  
**Answer C is correct.**  
 Answer D is wrong.

Question #88

Answer A is wrong. Technician B is also right; setback is designed into the suspension of some vehicles.  
 Answer B is wrong. Technician A is also right; if setback is measured on a car that should not have any setback, it usually indicates collision damage.  
**Answer C is correct.** Both Technicians A and B are right.  
 Answer D is wrong. Both Technicians A and B are right.

## Question #89

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** Only manufacturer-approved power steering fluid should be used.

## Question #90

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Although within specs, it is best to adjust to the preferred specification where possible.

Answer D is wrong.

## Question #91

Answer A is wrong. A bent center link would affect the alignment more than the steering effort.

**Answer B is correct.** Any seized part will add resistance to the steering.

Answer C is wrong.

Answer D is wrong.

## Question #92

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** If the shaft bearing or bushing is worn, the seal will wear due to excessive movement.

Answer D is wrong.

## Question #93

Answer A is wrong. The pump and lines should be flushed.

Answer B is wrong. Adjustments should be made before installation.

Answer C is wrong. The rack should be centered.

**Answer D is correct.**

## Question #94

**Answer A is correct.** Worn control arm bushings can cause the caster angle to be out of limits.

Answer B is wrong. Caster angles do not cause abnormal tire wear patterns.

Answer C is wrong.

Answer D is wrong.

## Question #95

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** The clamp must be positioned in such a way so that it squeezes around the solid portion of the sleeve equally and not at or on the slot. The clamps are usually rotated so that the open end is down, or otherwise positioned so it will not come in contact with anything during travel while turning.

Answer D is wrong.

## Question #96

Answer A is wrong. A light coating of oil is normal.

Answer B is wrong. Steering dampers cannot be resealed.

Answer C is wrong.

**Answer D is correct.**

Question #97

Answer A is wrong. Stabilizer bars do not affect ride height.

Answer B is wrong. Shock absorbers help dampen bounce.

Answer C is wrong.

**Answer D is correct.**

Question #98

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Many times, the shock will need to be removed then the spring compressor needs to be positioned to compress the spring. This removes the pressure from the control arm.

Answer D is wrong.

Question #99

Answer A is wrong. This does not remove the load from the ball joint.

Answer B is wrong. This is a non-load-carrying ball joint.

Answer C is wrong.

**Answer D is correct.**

Question #100

**Answer A is correct.** The bearing and race needs to be replaced as a unit due to wear or damage to one or the other.

Answer B is wrong. Not all bearings have failures at the same time.

Answer C is wrong.

Answer D is wrong.

Question #101

Answer A is wrong. If the steering was in need of service, the vehicle would not be experiencing problems after turning.

Answer B is wrong. Torque steer is only noticeable during acceleration.

Answer C is wrong. The complaint said nothing about the problem occurring after hitting bumps in the road.

**Answer D is correct.**

Question #102

**Answer A is correct.**

Answer B is wrong. Camber/caster plates only cause noise when they have become loose or have not been tightened properly.

Answer C is wrong.

Answer D is wrong.

Question #103

**Answer A is correct.** The front adjustments are based on the rear settings.

Answer B is wrong. The rear wheels are always aligned before the front wheels on a four-wheel alignment.

Answer C is wrong.

Answer D is wrong.

Question #104

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Any excessive runout will cause a vibration. The tires may need to be repositioned on the wheel, and rebalanced.

Answer D is wrong.

## Question #105

Answer A is wrong. An overloaded vehicle would not affect tire wear on the front of the vehicle.

Answer B is wrong. Hard cornering would not produce the kind of tire wear described.

**Answer C is correct.**

Answer D is wrong. A bent center link would change the toe angle.

## Question #106

Answer A is wrong. Included angle is always a concern and can cause tire wear.

**Answer B is correct.** This can effect camber and scrub radius.

Answer C is wrong.

Answer D is wrong.

## Question #107

**Answer A is correct.**

Answer B is wrong. Never run the vehicle with different air pressures on either side of the vehicle; follow manufacturer's recommendation.

Answer C is wrong.

Answer D is wrong.

## Question #108

Answer A is wrong. Sector lash should be adjusted last.

Answer B is wrong. Worm bearing preload should be adjusted first.

Answer C is wrong.

**Answer D is correct.**

## Question #109

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Some power steering systems have an adjustable power steering valve. If the alignment is correct and there is no tire causing a pull, there may be a problem with an internal leak or adjustment.

Answer D is wrong.

## Question #110

**Answer A is correct.** The steering wheel should not move because it can damage the air bag system clockspring.

Answer B is wrong. The clockspring connector is not removed.

Answer C is wrong.

Answer D is wrong.

## Question #111

Answer A is wrong. A bypassing spool valve usually causes hard steering in one direction.

Answer B is wrong. An overadjusted sector shaft will cause binding over center.

**Answer C is correct.**

Answer D is wrong. Loose worm bearing preload will cause free play in the gear.

## Question #112

**Answer A is correct.** The system is matched with specific pressure and flow requirements. The same performance needs to be maintained.

Answer B is wrong.

Answer C is wrong.

Answer D is wrong.



Question #113

**Answer A is correct.** Many balancers use an algorithm that incorporates both static and dynamic balances.

Answer B is wrong. Bubble balancers balance in a static mode only.

Answer C is wrong.

Answer D is wrong.

Question #114

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Leaf springs that shift will cause a change in the thrust line, change rolling direction and tracking problems, in addition to tire wear.

Answer D is wrong.

Question #115

Answer A is wrong. Worm bearing preload should be adjusted first.

Answer B is wrong. The ball nut should be centered when making sector lash adjustments.

Answer C is wrong.

**Answer D is correct.**

Question #116

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** Set back can be either on the right or left side. Although not adjustable, there is a limit.

Question #117

Answer A is wrong. Defective rear control arm bushings are a likely cause of incorrect thrust angle.

Answer B is wrong. A bent rear control arm mount is a likely cause of incorrect thrust angle.

**Answer C is correct.**

Answer D is wrong. A bent rear control arm is a likely cause of incorrect thrust angle.

Question #118

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** This demonstrates a rotating torque adjustment.

Question #119

**Answer A is correct.**

Answer B is wrong. Realigning the vehicle will not repair the problem.

Answer C is wrong. There is no need to put maximum air pressure in the tires.

Answer D is wrong. Tightening the wheel nuts will not noticeably affect runout, or cause a pull problem.

Question #120

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Memory steer is when the vehicle fails to return straight, or wants to wander to the direction it was last turned.

Answer D is wrong.

## Question #121

**Answer A is correct.** This allows the box to shift under the pressure of a turn.

Answer B is wrong. If the steering column were damaged, it would affect the turning radius in both directions.

Answer C is wrong.

Answer D is wrong.

## Question #122

**Answer A is correct.** This simple adjustment may need just a small amount to solve the complaint. It is easier to do this first, especially since there is low mileage.

Answer B is wrong. Removing the rack for an inspection is too extensive; first make a pinion shaft bearing preload adjustment.

Answer C is wrong.

Answer D is wrong.

## Question #123

Answer A is wrong.

**Answer B is correct.** When operating outside of a "normal" condition, loading the vehicle helps to obtain more accurate readings/adjustments.

Answer C is wrong.

Answer D is wrong.

## Question #124

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** The same procedure must be used for the rear and should not be overlooked.

Answer D is wrong.

## Question #125

Answer A is wrong. Sway bars are also called stabilizer bars.

Answer B is wrong. The sway bar *does* pivot in its mounts.

**Answer C is correct.** The lower control arms are mounted to the frame directly.

Answer D is wrong. The sway bar *does* transfer movement.

## Question #126

Answer A is wrong.

Answer B is wrong.

Answer C is wrong.

**Answer D is correct.** Driveline component alignment may cause this symptom.

## Question #127

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Directional tires need to be kept on the correct side of the vehicle. Air slots on directional wheels direct air to the brakes.

Answer D is wrong.

## Question #128

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** If the bushing is in good condition, silicone lubricant can be used.

Answer D is wrong.

Question #129

Answer A is wrong. Torsion bars are made to match either left or right and are not interchangeable.

Answer B is wrong. Ride height is addressed before alignment begins.

Answer C is wrong.

**Answer D is correct.**

Question #130

**Answer A is correct.**

Answer B is wrong. If a wheel or tire assembly was badly out of round, it would cause a violent vibration.

Answer C is wrong.

Answer D is wrong.

Question #131

Answer A is wrong. There is no rear caster adjustment

Answer B is wrong. Rear wheels do not have this provision.

Answer C is wrong. This is not an ABS component.

**Answer D is correct.** Shims, in different thicknesses, are used for toe adjustment and sometimes camber correction.

Question #132

Answer A is wrong. Both technicians are correct.

Answer B is wrong. Both technicians are correct.

**Answer C is correct.** Both technicians are correct. Directional tires and wheels need to be kept on the correct side of the vehicle.

Answer D is wrong. Both technicians are correct.

Question #133

Answer A is wrong. Both technicians are correct.

Answer B is wrong. Both technicians are correct.

**Answer C is correct.** Both technicians are correct. Any component that has a provision for lubrication must be greased as prescribed in the maintenance schedule. Removing the tie rod eliminates steering linkage drag while checking the kingpins.

Answer D is wrong. Both technicians are correct.

Question #134

Answer A is wrong. Both technicians are correct.

Answer B is wrong. Both technicians are correct.

**Answer C is correct.** Both technicians are correct. The shim may have been installed to compensate for something other than the spindle and should be reinstalled when replacing the spindle. Anytime a steering or suspension component is replaced, a complete alignment needs to be done.

Answer D is wrong. Both technicians are correct.

Question #135

**Answer A is correct.** Damaged or bent spindles or struts cannot be repaired.

Answer B is wrong. Shims cannot make this amount of correction.

Answer C is wrong. Front wheel adjustments will not affect rear angles.

Answer D is wrong. Does not address problem.

Question #136

Answer A is wrong.

Answer B is wrong.

**Answer C is correct.** Old weight position does not matter. A new balance must be performed regardless.

Answer D is wrong.

Question #137

Answer A is wrong. Kingpins are not part of the steering gear box.

Answer B is wrong. Kingpins will not contribute to a vibration.

**Answer C is correct.** Looseness allows steering wander.

Answer D is wrong. If the kingpin was seized, it would add resistance to the steering effort.

Question #138

**Answer A is correct.** This aids in removal and installation.

Answer B is wrong. This may damage the beads.

Answer C is wrong. Never exceed 50 psi.

Answer D is wrong. Use appropriate tire machine equipment.

Question #139

**Answer A is correct.** This is an input signal; used to increase idle to compensate for power steering load.

Answer B is wrong. Would be "0" volts.

Answer C is wrong.

Answer D is wrong.

Question #140

Answer A is wrong.

**Answer B is correct.** Anytime a steering or suspension component is replaced a four-wheel alignment needs to be performed, starting with rear wheels.

Answer C is wrong.

Answer D is wrong.

Question #141

Answer A is wrong. A bent I-beam will not cause looseness.

Answer B is wrong. No ball joint with a kingpin.

**Answer C is correct.** This will allow excess movement.

Answer D is wrong. An adjustment will not remove looseness.

Question #142

**Answer A is correct.** Sends false signal and may result in higher than normal idle. May also prohibit air conditioning operation.

Answer B is wrong. Would show normal.

Answer C is wrong. An open here would show normal in this condition.

Answer D is wrong. An open here would show normal in this condition.

# Glossary

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- Adjusting sleeve** An internally threaded sleeve located between the tie rod ends that, when turned, moves the front or rear wheels when toe is being adjusted.
- Aftermarket** A term used for parts and equipment sold by companies independent from the vehicle manufacturer.
- Air bag** A passive restraint system having an inflatable bladder located in the steering wheel and in the dash ahead of the passenger seat.
- Air shock** A shock using air pressure and a rubberized bag that is a part of the shock absorber.
- Air shock system** Also known as a secondary air leveling/suspension system. Uses air pressure and a rubberized bag that is a part of the shock absorber.
- Air suspension system** A suspension system that uses compressed air for vehicle springing.
- Alignment** The act of lining up; of being in a true line.
- Alignment rack** A drive-on device used for alignments.
- Axle** A crossmember supporting a vehicle on which one or more wheels are mounted.
- Axle flange** The outside end of the axle where the wheel/drum/rotor attaches.
- Ball joint** A joint or connection where a ball rides in a socket.
- Battery** A device that stores electrical energy in chemical form.
- Bearing** An antifriction device having an inner and outer race with one or more rows of steel balls.
- Belt** A device used to drive the water pump and other accessories.
- Boot** A flexible rubber or plastic cover used over a component to protect it from the elements.
- Bushing** A sleeve, usually bronze, inserted into a bore to support a shaft.
- Camber** The inward or outward tilt of the wheel and tire assembly as viewed from the front or rear of the vehicle.
- Capacitor** A device used for the temporary storage of an electrical charge.
- Caster** The angle between the steering/spindle axis and vertical, as viewed from the side of the vehicle.
- Center bolt** A term used for a bolt that holds the spring leaves in a fixed position and indexes the spring to the axle housing.
- Center link** A steering linkage part that is connected to the tie rod ends and the Pitman arm to transfer the rotating motion of the steering box to linear motion necessary to move the wheels from side to side.
- Chassis** The frame of a vehicle.
- Clockspring** Device attached to the steering column and the steering wheel that insures good electrical paths for the air bag assembly signals.
- Coil spring** A spring steel bar or rod that is shaped into a coil to provide an up-and-down springing effect.
- Conicity** A tire condition that occurs when the tire tread is installed off center on the carcass, creating a cone shape. This causes the vehicle to pull to one side and is diagnosed by changing the tire position on the vehicle.
- Connecting link** A link in which a removable rod or plate facilitates connecting or disconnecting the ends of a chain.
- Control arm** The main link between the vehicle wheels and frame.
- Crash sensor** Normally open input of the air bag system that has gold plated contacts that close when subjected to a predetermined deceleration force.
- Drive train** All of the components required to deliver engine power to the road surface.
- Dynamic** Pertaining to energy, force, or motion in relation to force. A term used when wheels are balanced using equipment that spins the tire and wheel assemblies.
- Eccentric adjuster** An adjustment system that converts a rotary motion into a reciprocating motion.
- Engine** The prime mover of a vehicle that converts chemical energy (fuel) into mechanical energy (motion).
- Engine block** A part of the engine containing the pistons and crankshaft.
- Epoxy** A plastic compound often used for mending or patching small areas.
- Exhaust** The harmful burned and unburned gases that remain after combustion; the pipe extending from the muffler to vent the gases.
- Exhaust system** The exhaust manifold, catalytic converter, muffler, and pipes that vent harmful burned and unburned gases, a product of combustion, to the atmosphere.
- Factory bulletin** An official periodic publication by the vehicle manufacturer with service tips and hints.
- Flush** To use a fluid to remove solid and semisolid particles.
- Frame** The substructure of a vehicle.
- Free play** The movement permitted between two mating and/or rotating parts.
- Front cradle** Heavy metal framework that attaches to the chassis and supports the powertrain and allows the attachment of many of the suspension and steering parts.
- Front-wheel drive** A drive system that transmits power through the front wheels.
- Full assist** A term used with variable assist steering systems to signify normal power system operation without restrictions.
- Fuse** A safety device to guard against an electrical overload.
- Grease** A heavy lubricant.
- Gum** A term used in the automotive industry when petroleum products break down and form a gummy substance on the surfaces they contact.
- Height sensor** A sensor used to monitor the corner height of a vehicle for the level control system.

- Hose** A rubber or synthetic tube used to transfer fluid or vapor.
- Hub runout** The amount of wobble out of plane measured at an outside machined surface of the hub.
- Idler arm** A pivoting component that attaches to the side of the vehicle opposite the Pitman arm and supports the center link, allowing parallel movement of the steering linkage.
- Idle relearn** The routine of the computer that resets idle requirements when a disconnected battery has been reconnected.
- Intermittent problem** A problem that only occurs occasionally.
- Isolator pad** A rubber or synthetic device used to insulate two parts to reduce noise and/or vibration.
- Km/hr** An abbreviation for kilometers per hour; one km/hr is equal to 1.609 mph.
- Knuckle** The part around which each front wheel pivots as it is steered.
- Leaf spring** A vehicle suspension component having one or more thin steel leaves.
- Load carrying** A term often used when referring to ball joints. It could be the upper or lower ball joint depending on where the spring supporting the vehicle weight is located.
- Load rating** A term used to designate the maximum weight a tire is designed to support; the maximum weight a vehicle is designed to support and/or carry.
- Lubricant** A fluid used to reduce friction between moving parts.
- Lubricate** To provide lubricant to areas that require such service.
- MacPherson strut** An independent suspension part that, in connection with the coil spring that supports the vehicle, serves as a shock absorber. If on the front of the vehicle, the spindle, ball joint, and steering arm are attached.
- Memory (memory code)** A term used for certain fault codes stored in the module of an electronically controlled computer that happened during past operation but is not now present as a hard fault.
- Module** A solid-state device composed of the components required to monitor, control, and sometimes diagnose many of the systems of today's vehicles.
- MPH (mph)** An abbreviation for miles per hour.
- Neutralized** A term used for allowing a system to settle in a nonstressed position. Used in reference to exhaust systems, powertrain mounts, and suspension mounts.
- Non-load-carrying** A term used in reference to the ball joints on a vehicle that hold the suspension parts in place, but do not support the vehicle load.
- Oil** A mineral based lubricant.
- O-ring** Round or square donut-shaped rubber or synthetic device used to seal a joint or shaft.
- Pinion shaft** A shaft used to support a pinion bearing and a pinion.
- Pitman** A term often used for the Pitman arm and Pitman shaft.
- Pitman arm** An arm attaching the steering box sector shaft to the center link that changes the rotating forces of the steering box to linear motion and moves the front wheels from side to side.
- Power steering** A power assisted steering system.
- Power steering analyzer** A diagnostic device that tests flow, pressure, and operation of everything hydraulic in the power steering system.
- Power steering fluid** A special fluid used in power steering systems.
- Power steering pump** A component of the power steering system providing fluid power for operation.
- Power supply** An electrical or electronic device that provides a predetermined power to satisfy a particular requirement.
- Pre-alignment check** A series of checks the technician must perform before an alignment is done. All steering and suspension parts are checked for looseness, wear, damage, and general condition.
- Preload** The specified pressure applied to certain parts during assembly or installation.
- Pressure** A force per unit area, usually measured in pounds per square inch (psi) or kilopascals (kPa).
- Pressure control valve** A device used to regulate and/or control a pressure.
- Primary air suspension system** The term used for a type of vehicle system that uses air, instead of coil, leaf, or torsion bar type springs, to support the vehicle weight.
- Pulley** A wheel-shaped belt-drive or belt-driven device.
- Rack** A horizontal toothed bar in the rack-and-pinion power steering sector.
- Rack and pinion** A type of steering assembly having a pinion on one end that engages in a horizontal-toothed rack with tie rods at either end that attaches to the steering arms.
- Rack body** A part of the steering system containing the rack.
- Rack guide** The guide on which the rack is positioned.
- Rack shaft** A horizontal-toothed part of the rack and pinion.
- Radius** A term used when referring to the turning radius of a vehicle; a line extending from the center of a circle to its boundary.
- Rear end** The differential and final drive assembly on a rear-wheel-drive vehicle.
- Rear springs** Coil- or leaf-type suspension components at the rear of a vehicle.
- Rear strut** A shock-absorber-type component that supports the rear of the vehicle.
- Redundant** A duplication; a secondary or backup system.
- Relay** An electromagnetic/mechanical switch.
- Road test** To drive a vehicle and determine needed repairs.
- Rpm** An abbreviation for revolutions per minute.
- Sector shaft** A shaft on which the sector gear is located.
- Self test** A computer function that scans subsystems and systems to provide data for troubleshooting.
- Sensor** An electronic device used to monitor relative conditions for computer control requirements.
- Shackle bushing** Insulated bushings to help prevent the transfer of noise and road shock.
- Shim** A thin metal spacer used to align two parts.
- Shimmy** A harsh side-to-side vibration of the steering transmitted to the steering wheel; usually caused by loose suspension parts or front wheel imbalance.
- Shock absorber** A hydraulic cylinder located at each wheel of the suspension system to dampen road shock.

- Silencer pad** A rubber or synthetic device used to insulate two parts to reduce noise and/or vibration.
- Solenoid** An electromechanical device used to impart a push-pull motion.
- Speed rating** A tire rating that indicates the maximum safe speed the tire is designed for.
- Speed sensor** An electrical device that can sense the rotational speed of a shaft and transmit that information to another device, such as a computer.
- Spindle** A shaft, stub axle, or knuckle upon which wheel hubs and wheel bearings ride.
- Spring** A coil- or leaf-type device used in the suspension system for springing the vehicle weight.
- Stabilizer bar link** Long metal bolts with insulators and support washers that attach the stabilizer bar to the outer suspension or body.
- Static** A commonly used term for a balancing process that compensates for an imbalance condition by distributing the weight equally around a part without rotating the part being balanced.
- Steering** The method whereby the vehicle is kept on course.
- Steering arm** An arm attached to the steering knuckle/spindle/strut that moves those parts in response to steering wheel movements.
- Steering axis inclination (SAI)** The angle of a line through the center of the upper strut mount and lower ball joint in relation to the true vertical centerline of the tire, as viewed from the front of the vehicle.
- Steering box** A general term used for the steering mechanism at the end of the steering column.
- Steering column** The tubing through which the steering shaft mounts and rotates.
- Steering damper** A device that reduces or eliminates road shock and vibration.
- Steering knuckle** The part which pivots in response to forces from the steering box or rack-and-pinion gear and causes the tires to hold the vehicle on course and control the direction of movement of the vehicle.
- Steering linkage** The assembly of the tie rods, idler arms, and links that make up the system that transfers steering motion to the front wheels.
- Steering linkage damper** A shock-absorber-type device that connects the steering linkage to the framework of the vehicle and absorbs some of the road shock and dampens most of the vibrations. Such devices are used on many trucks and off-road vehicles.
- Steering wheel** The wheel located at the top of the steering shaft that the driver uses to steer the vehicle.
- Steering wander** The tendency of a vehicle to pull to one side when driven straight ahead.
- Strut** A component, connected at the top of the steering knuckle to the upper strut mount, that maintains the knuckle position.
- Subframe** A partial front or rear chassis frame used on some vehicles to support the powertrain and suspension and steering assemblies.
- Suspension** The system that supports the weight of the vehicle and provides a comfortable and safe environment for the occupants.
- Suspension height** The height of the vehicle at its four corners.
- Sway bar** A bar in the suspension system that connects the two sides together in a manner that cornering forces or a road shock is shared by both wheels.
- Technical service bulletin** Bulletins provided by the manufacturer regarding production changes and corrections to aid the technician in troubleshooting practices and procedures.
- Tie rod** The steering linkages between the idler arm, Pitman arm, and steering arm.
- Tie rod end** A pivoting ball-and-socket joint located at one end of the tie rod.
- Tire information label** A label required by the federal government and usually placed on the inner glove box door or on a door post on the passenger side of the vehicle. It contains all of the information needed to choose a safe tire of the proper size for the vehicle.
- Tire lead** A term used for the condition that occurs when the plies, belts, or tread are not level across a tire and are somewhat cone shaped. This causes a lead or pull to one side as the vehicle is driven and is worse when that tire is on the front of the vehicle.
- Tire wear pattern** The way in which a tire wears due to front end or balance problems.
- Toe** A suspension dimension; the difference between the extreme front and extreme rear of a tire.
- Toe adjustment** The methods provided by the manufacturer to move the front or rear wheels so there is a specified distance between a centerline of each front wheel, and the centerline of the rear wheels.
- Torque** The measure of a force producing tension and rotation around an axis.
- Torsion bar** A long, spring steel bar that is used instead of a coil or leaf spring. It usually has an adjustment at one end that makes it possible to easily adjust suspension height.
- Transmission** A manual or automatic device; a part of the drive train that provides different input and output ratios.
- Unscheduled deployment** A term used when referring to air bag systems that could be set off without the vehicle being involved in a crash severe enough for normal deployment. Also, accidental deployment of the air bag by not following the vehicle manufacturer's safety precautions.
- Valve stem** A device found in the rim of a tire to provide a means of adding air and/or checking its pressure.
- Variable orifice steering system** High power steering assistance is provided during low speed cornering and parking; normal power steering assistance is provided at higher speeds.
- Varnish** A thick buildup of a varnish type material that occurs when petroleum products break down. It coats the internal parts of any unit involved and is common in power steering systems, transmissions, and engines that do not have their fluids changed at recommended intervals.
- Vehicle** A means of conveyance or transportation.
- Vehicle ride height** The specified normal distance between the vehicle chassis and a level surface.
- Wheel** A circular frame or hub of an axle to which a tire is mounted.
- Wheel balance** The equal distribution of the weight of a wheel with a mounted tire.
- Worm shaft** A steering gearbox component having spiral grooves.

# Notes











